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DECEMBER 1958
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(See Page 39)

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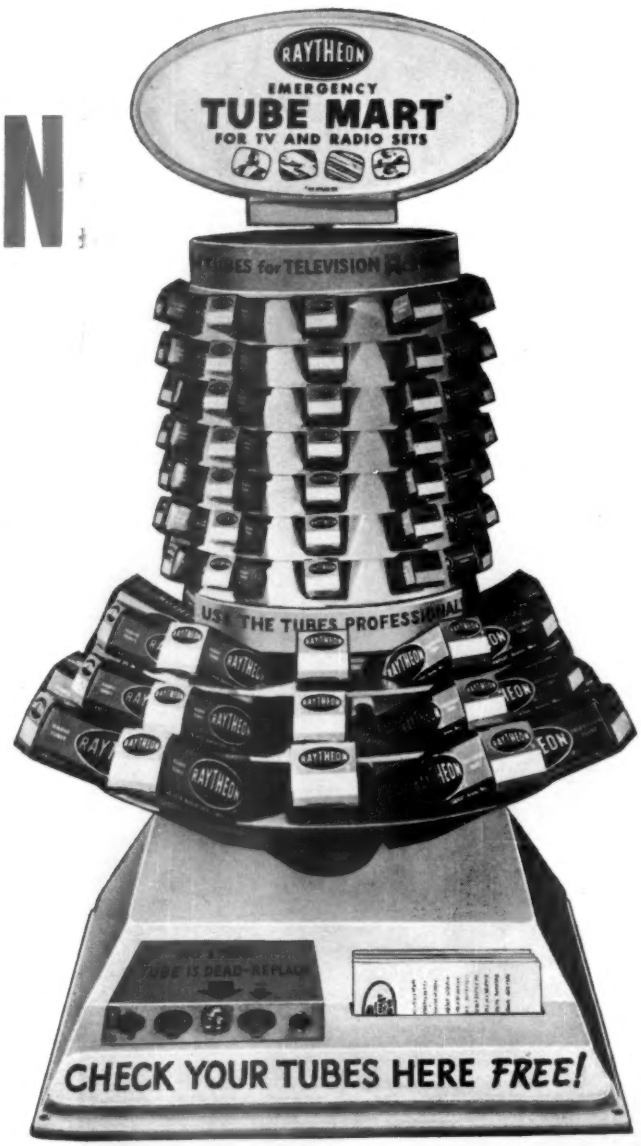

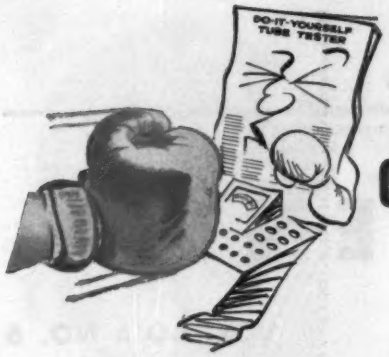

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ELECTRONICS—GENERAL

HIGH FIDELITY AND AUDIO

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AMATEUR AND COMMUNICATIONS

DEPARTMENTS

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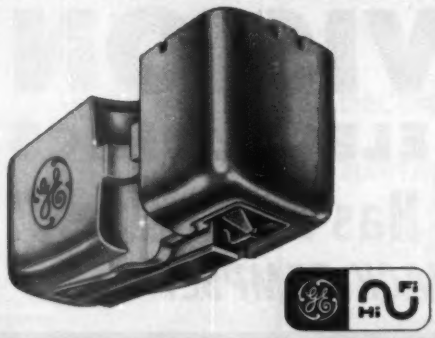
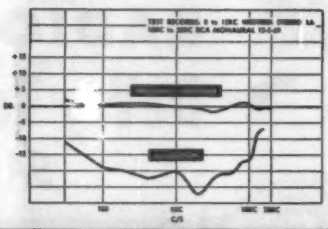
5 new G-E "Stereo Classic" components

1 New "Golden Classic" stereo-magnetic cartridge



• Plays both stereo and monaural records • Full frequency response, 20 through 20,000 cycles • "Floating armature" design increases compliance and reduces record wear. Effective mass of stylus approximately 2 milligrams • High compliance in all directions—lateral compliance 4 x 10^{-6} cm/dyne; vertical compliance 2.5 x 10^{-6} cm/dyne • Recommended tracking force with professional-type tone arm 2 to 4 grams • Consistently high separation between channel signals. (Specifications for Model GC-5.)



Model GC-7 (shown left) with .7 mil diamond stylus....$23.95*
Model GC-5 (for professional - type tone arms) with .5 mil diamond stylus....$26.95*
Model CL-7 with .7 mil synthetic sapphire stylus.....$16.95*

2 New "Stereo Classic" tone arm

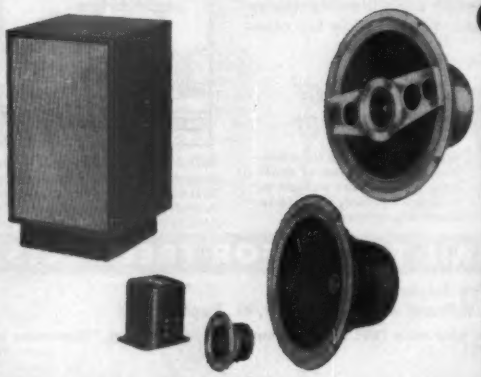
• A professional-type arm designed for use with G-E stereo cartridges as an integrated pickup system • Features unusual two-step adjustment for precise setting of tracking force from 0 to 6 grams • Lightweight brushed aluminum construction minimizes inertia; statically balanced for minimum friction, reduced stylus and record wear. $29.95*

New 40-watt "Stereo Classic" amplifier

• Full, balanced 20-watt power output from each channel at same time • Flat response within 0.5 db from 20 to 20,000 cycles • Outstanding sensitivity, extremely low hum and noise level • Integrated single-knob controls for easy simultaneous adjustments of both stereo channels. Contour control provides smooth, gradual bass boost without apparent change in sound intensity. $169.95*

New FM-AM tuner

• Receives weak signals with unusually low distortion, hum and noise level • No audible drift • Visual meter provides center channel tuning of FM and maximum AM signal • RF amplifier stage in both FM and AM increases sensitivity • FM multiplex jack for stereo adaptor. $129.95*



5 New "Stereo Classic" speaker systems

• New Extended Bass system produces 4 times the undistorted power at low frequencies (+6db) as standard 12" speakers in the same enclosure • Amplifiers of only moderate power needed because efficiency is 2 to 4 times higher than comparable systems • New direct radiator tweeter provides unusually smooth response and exceptional sound dispersion at higher frequencies without unnatural tone coloration.

Model LK-12: Separate woofer-tweeter kit with crossover network $89.95*
Model LC-12: Same basic woofer with tweeter coaxially mounted in front and crossover network $89.95*
Model LH-12: Separate woofer, tweeter and crossover factory installed in 2 cu. ft. wood enclosure ..$129.95*

Hear G-E "Stereo Classic" components at your dealer. For more information and nearest dealer's name, write General Electric Company, Dept. RT128, W. Genesee St., Auburn, N. Y.
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...for the Record

By **W. STOCKLIN**
Editor

FOUR HUNDRED AND SIXTY-SIX YEARS

FOUR hundred and sixty-six years from the time Columbus discovered the Western Hemisphere, and almost to the hour, the United States Air Force launched one of its intended rocket flights to the moon. True, it wasn't as successful as had originally been hoped but the results that were attained were certainly a tremendous achievement. They were fantastic if one were to consider the relatively few years that scientists have been working on rocket propulsion.

The October 11 attempt to reach the moon resulted in a rocket traveling 79,000 miles into outer space. Since the moon is 221,463 miles away at its closest point to the earth, the distance reached was slightly better than one-third of the way. This may not look impressive but actually the rocket attained 98% of its objective in that only 2% additional velocity would have been required to cover the full distance.

The development pace is rapid. Shortly after the moon rocket attempt the Advanced Research Projects Agency, Department of Defense, announced and previewed for the first time a new experimental manned rocket ship, the X-15. It was developed by *North American Aviation* and flight tests up to 4000-4500 miles-per-hour are scheduled for January. According to information released to date, this new rocket ship will attain a height of 100 miles into the atmosphere. This will be man's first flight into outer space. Roy Johnson, director of the ARPA, made an announcement at the recent *CBS Laboratories* dedication in Stamford, Connecticut, that man will reach outer space within two to two and one-half years. In order to achieve this goal scientists must solve the re-entry problem. If this can be done within the time period mentioned by Mr. Johnson, the next foreseeable problem confronting the scientists is the dangerous radiation region between the earth and the moon. Work is progressing rapidly in accumulating all possible information on this radiation barrier and with the faith we have in the ability of the scientists working on this problem, it should not take too many years to solve. As far as we know now, a trip to the moon by man is many years closer than one could have expected a year ago.

It is unfortunate in some ways that many people in our country do not realize the near-future importance of these scientific developments that are occurring daily. Then, again, this is not unusual. Time must pass and people have to look back to be conscious of the great strides being made. To make all this possible, credit must be given to those individuals who have worked on the development of heat-resistant metals and the development of propulsion fuels (liquids and solids), but the greatest achievements and honors, at least in our opinion, go to those men who have been working on the electronic equipment which make outer space flight possible.

Electronics plays an extremely vital role in the control of missiles from the launching pad, its tracking into outer space, and only through electronics are we able to obtain scientific information from the rocket as it progresses from its launching into space. Our industry should be extremely proud of the role it is playing in these developments.

Although this phase of the electronic industry is small in comparison to the whole, the contributions being made are on a scientific level and can result only in man's furthering his knowledge of the universe. However, this is a two-way street. In return for the vital role played by this small but very important segment of the electronics industry, benefits accrue not only to the man-on-the-street but also to the electronics industry as a whole. For example, it will be possible to set up world-wide communication networks and relay stations. These might be used to transmit programs over a much greater area than is now possible. We will also be able to relay information quickly and over greater distances by use of satellites that are in permanent orbit above the earth. Such satellites would operate either as passive reflectors or as active transmitting stations themselves. Furthermore, much of the guesswork will be taken out of the science of meteorology. Accurate weather predictions that will be made far in advance will certainly become possible and this is just the beginning. For all of this and for much yet to come, we must be thankful for the brilliant combination of rocketry and electronics.

—30—

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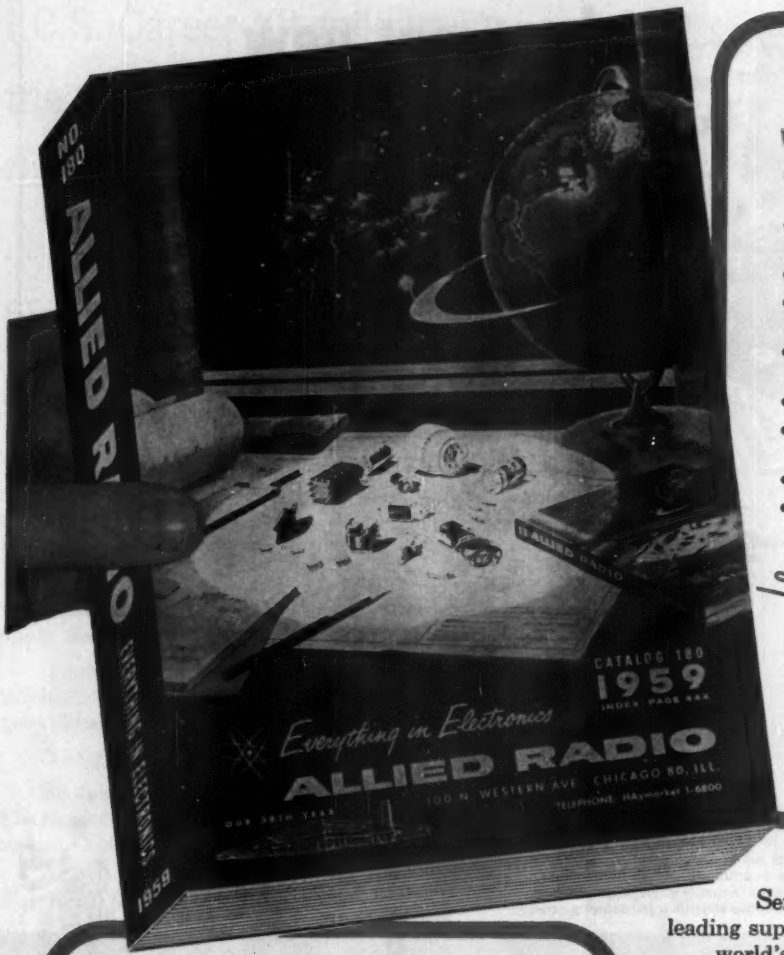

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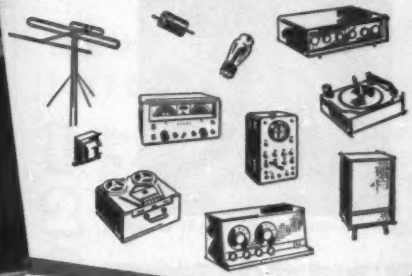

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TESTING SPEAKERS

To the Editors:

Very rarely does one get the satisfaction given by reading an article so full of meaty information and so well written as the one "Testing the Properties of Loudspeakers" by Mr. J. L. Smith in your August, 1958 issue.

It is all too common in the electrical field, and more particularly in the hi-fi field, to find articles that are bogged down by involved technical details to the point of confusion, or else to find that the author — in an attempt to reach the popular reader—has written down to the cellar level of vague and trite generalities. In contrast, one finishes Mr. Smith's article with a feeling that here is a distillation of worthwhile years of experience, presented in a simple and understandable fashion and with a healthy respect for the intelligence of the reader.

SOL D. PRENSKY
EE Department
Fairleigh Dickinson University
Rutherford, New Jersey

To the Editors:

I have read with great interest the article on testing loudspeakers in your August issue. I feel more articles on these same lines could be a great help not only for the purpose of evaluation, at least with some degree of precision, but also to increase knowledge about these transducers.

JORGE MORALES, E. I.
Radio Progreso Broadcast Station
Holguin, Cuba

We have another article along a somewhat similar vein in the works at present on testing loudspeakers. Watch for it.—Editors.

• • •

PHOTORHYTHMICON

To the Editors:

With reference to your August issue, I would appreciate receiving additional information on the "Photorhythmicon —Dancing Lights" by Mr. Leon A. Wortman.

Can this instrument be purchased, and if so, at what price? Is it available fully wired or in kit form? If the unit is not available for purchase, I wonder whether or not a pictorial diagram of the system is available.

NORMAN K. ROBINSON
Garden City, Michigan

Both we and Author Wortman were really swamped with inquiries about the "Dancing Lights." The unit was homemade by the author from his own circuit and, as such, it cannot be purchased either wired or in kit form. We are also sorry that there are no pictorial diagrams available, since the author built the unit directly from his own schematic. Inquiries have been so heavy on this unit that perhaps we can induce Mr. Wortman to see if some equipment or kit manufacturer is interested in putting out the unit.—Editors.

• • •

SINE-TO-SQUARE WAVE ADAPTER

To the Editors:

On completing my breadboarding of Rufus Turner's "Improved Sine-to-Square Wave Adapter" in your June, 1958 issue, I seemed to have a circuit that was a pulse generator rather than a square-wave generator. In other words, the waveform was not balanced and the positive half cycles did not have the same duration as the negative half cycles. It seemed that this difficulty might be overcome by suitable bias on transistor V_1.

I experimented and found that adding a 2700-ohm resistor from the base of this transistor to the positive side of the battery produced an excellent balanced square wave. Also, I found that when feeding a low-impedance circuit, such as another transistor, it was necessary to increase the output capacitor to 1 μfd. in order to get good low-frequency response. I also got excellent results using 2N170 transistors in place of the more expensive 2N168A's.

I am certainly very pleased with the results I am now getting from the circuit.

C. W. EVANS
St. Louis, Missouri

Because of the variation among transistors, biasing the input transistor, as suggested by Reader Evans, would give a better square wave with a greater number of transistors that might be selected. Also, when the bias resistor is included, the resulting network serves to stabilize the input stage.—Editors.

• • •

DRILL CHUCK KEY

To the Editors:

Your August issue had a brief item on page 108 about chuck-key placement for electric drills. The main thing that I have against the suggestion is the placement of the key. If at any time someone should happen to hit the drill trigger with the key located as shown, it might fly up and hit the person in the face and cause injury.

I would prefer to see the band holding the key tied to the plug of the drill. Then the plug would have to be pulled in order to use the key, hence, there

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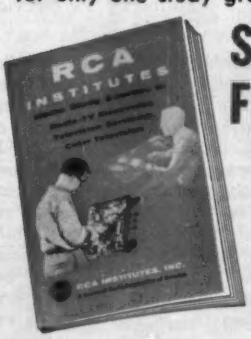

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T/Sgt. Glenn E. Craven
Radar Maintenance Tech., U.S.A.F.
Midwest City, Oklahoma

We're glad to pass along Sgt. Craven's suggestion.—Editors.

* * *

BENCH PUZZLER & SERVICE NOTES

To the Editors:

Your Radio & TV News has always pleased me in some manner since my first subscription. Your general interest articles are good and the technical articles have been a valuable staff on numerous occasions.

In the July, 1958 issue, the "Test Bench Puzzler" is the type of article I would like to see printed more often. I have a lot to learn with regard to servicing of television, and this type of article does help.

Along with the good, I must send the bad. I have in the past cut out and saved the "Service Notes" articles for troubleshooting reference. However, the July issue is going to be hard to record under a set manufacturer since the article is back-to-back. I realize much conflict is encountered in magazine make-up, but I wonder if this can be avoided.

Again, I say thanks for a fine magazine.

Donald C. Alverson
Cincinnati, Ohio

Concerning the matter of running the "Service Notes" back-to-back, we try to avoid this whenever possible. However, occasionally make-up problems prevent us from handling the items in the manner suggested by Reader Alverson.—Editors.

* * *

REALISTIC PROFIT MARGINS

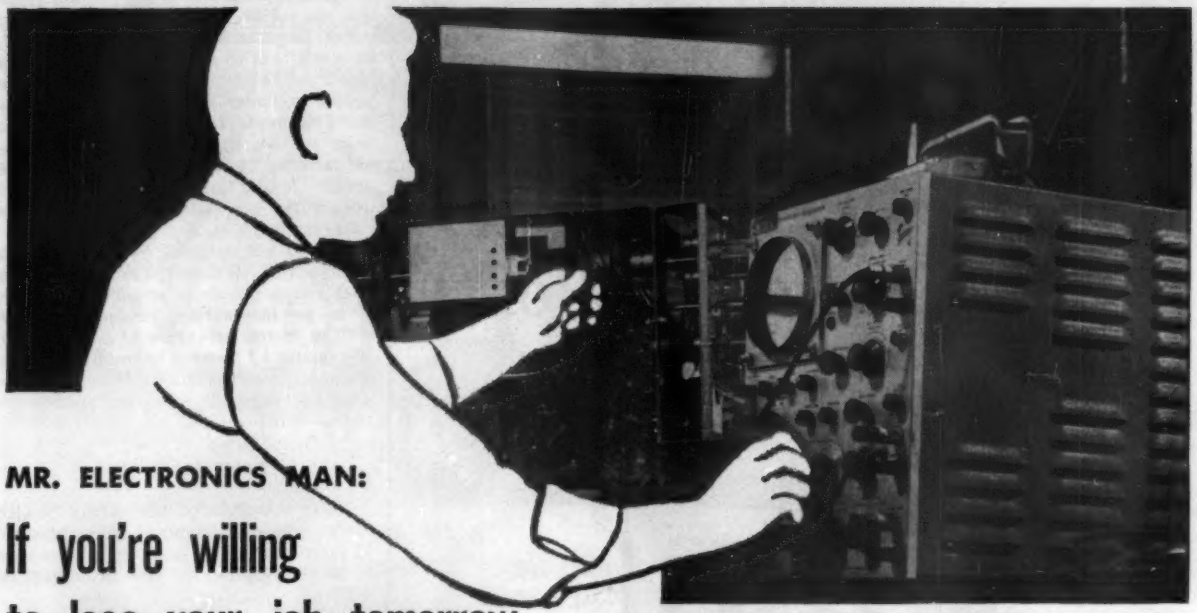
To the Editors:

While reading my September issue of your magazine, I came across the article by William Leonard in which he refers to drugstore tube sales and the do-it-yourself trend. He said in the article that it was the TV man's fault for the rise in this type of business.

I would like to know if your author were put in the same spot as the little guy whose only income is the sale of tubes and TV repair, would he have the same feeling about giving profits away as he expressed in the article?

Ed Rahm, Jr.
Mulberry TV Service
Toledo, Ohio

William Leonard knew, as we did, that many people in service disagree with the basic premise he advanced. However, we have seen any number of articles and editorials in the monthly organs of various service organizations where exactly the same position was advanced. The most recent one we recall appeared in the "Guild News" published by the Radio & TV Guild of Long Island. These people advanced the belief that the serviceman must be firm in establishing the fact that he is en-



MR. ELECTRONICS MAN:

If you're willing to lose your job tomorrow to a technically-trained man, *turn the page, mister*

Many of the men currently on the street are there for a reason. "As many as 8 out of 10 are deadwood," estimates the chief engineer of a medium-sized Philadelphia firm; the problem is to find the live ones. —*from ELECTRONICS MAGAZINE*

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Look at this partial listing of organizations that recommend CREI training for their own personnel: United Air Lines, Canadian Broadcasting Corp., Trans-Canada Airlines, Douglas Aircraft Co., The Martin Co., Columbia Broadcasting System, All-American Cables and Radio, Inc., Gates Radio Co., Canadair Ltd., Federal Electric Corp., and U.S. Information Agency (Voice of America).

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titled to a respectable fee for his services on which he must place primary value. Once he does this, they also feel, he can afford to sell tubes at something below customary markup, which many people consider unrealistic. The argument is made that, by attempting to take such a high markup on components rather than on labor, the service dealer leaves himself vulnerable to others who are willing to work on more realistic markups.

We do not necessarily endorse this view which William Leonard shares with many people in service. However, it is an interesting viewpoint worth calling to the attention of our readers. We would be pleased to publish similar arguments advanced by those who oppose the attitude indicated in the article.—Editors.

* * *

ARMY MARS NET

To the Editors:

Your schedule of the Army MARS net's technical broadcast that appeared in your September issue led me to tune in on the September 24th broadcast on 4030 kc.

The talk on test equipment for the blind ham and technician by Robert Gunderson certainly showed a very worthy use of MARS network. Not only was the talk highly informative, but it was a great inspiration to handicapped and non-handicapped listeners alike.

Reception conditions were good and all stations in the SSB network came in loud and clear.

E. GILBERT
New York, New York

We caught the broadcast too, and we can certainly attest to the fact that it was very worthwhile listening to.—Editors.

* * *

STANDBY TRANSMITTER MIKE

To the Editors:

Your article in the June issue entitled "Compact 35-Watt Standby Transmitter" states that a T17B carbon transmitter can be converted to use an F1 microphone unit.

On the strength of this information, I purchased an F1 unit, assuming that it would fit into the space where my T17B carbon button is presently placed. However, I find that the F1 unit is too large to fit the space, and there is no way to make the connections to the push-to-talk switch.

HARRIS M. PERRY, W4OBM
Virginia Beach, Virginia

According to Author Bumbaugh, he has had so many T17B's fitted with F1 units that it just never occurred to him to describe the method. He had a machine shop turn up a dural ring with inside threads to fit the T17B case, the outer half having a diameter to fit the F1 unit. A little lip on the outside edge served to retain the F1 unit. He considered the cost for this operation ($1.00) justified in view of the superiority of the F1 unit. Perhaps another way may suggest itself to our readers. —Editors. -30-

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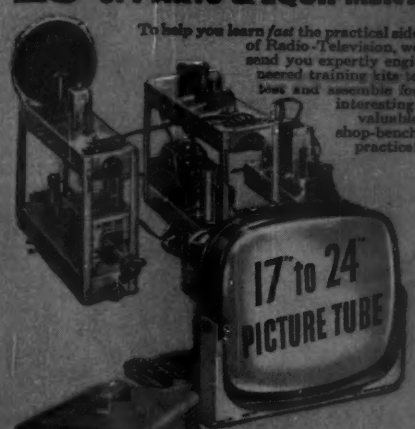

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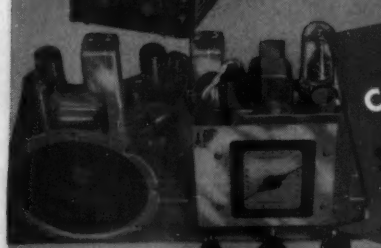

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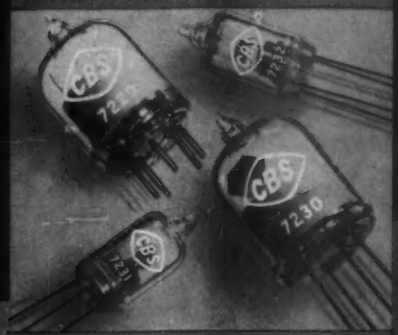

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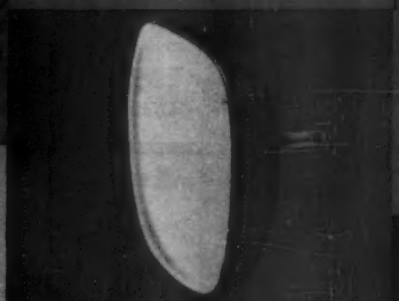
These CBS-Hytron originals introduce a new and growing family of krytrons, reliable cold-cathode trigger tubes. They replace relays and thyratrons in simplified circuits; control up to 500 amperes with inputs of less than 20 microamperes. Krytrons present another addition to CBS-Hytron's industrial tubes . . . most inclusive selection in the industry.

Most Comprehensive Diode Line

Of particular interest for their freedom from shorts and opens are these new indium-bonded computer diodes. The CBS-Hytron diode line has become the most comprehensive, including general-purpose or computer . . . germanium or silicon . . . glass or plastic, in a wide range of types.



More Dependable TV Picture Tubes

From the originator of the rectangular and CBS-Colortron picture tubes, these new 110-degree Silver Vision aluminized tubes offer the advantages of a picture that remains brighter and clearer throughout their longer life. A precision electron gun and uniformly controlled processes for aluminizing and screen settling assure dependability . . . the dependability of the best-known name in television.

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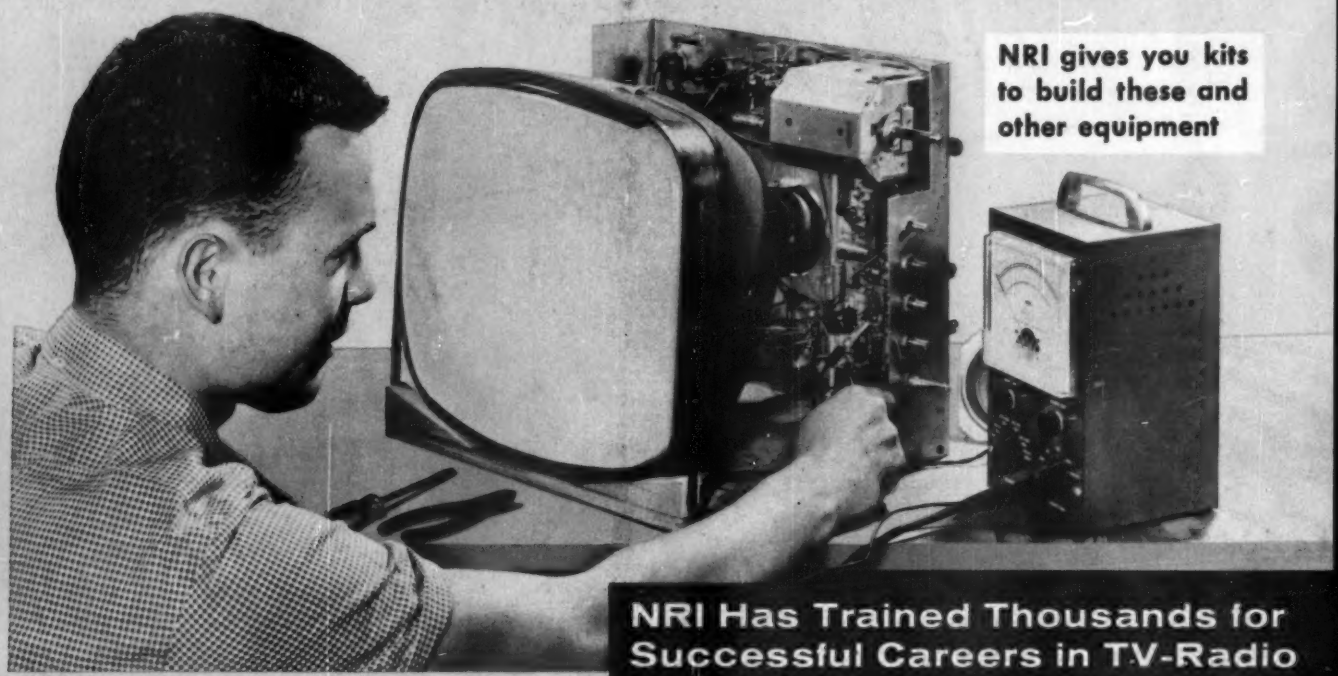

NRI gives you kits to build these and other equipment

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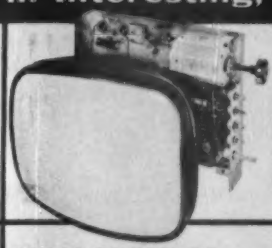

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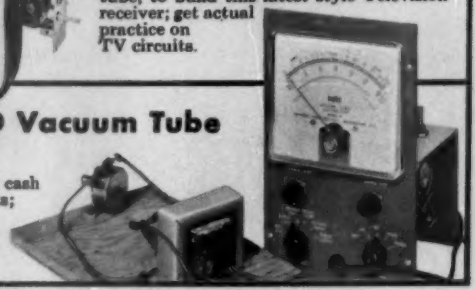

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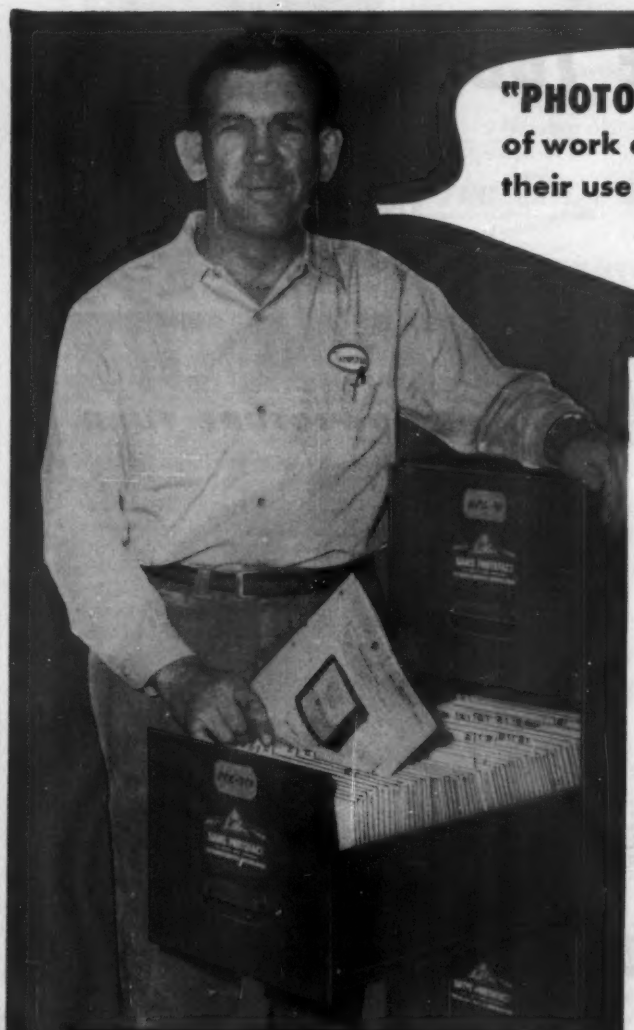

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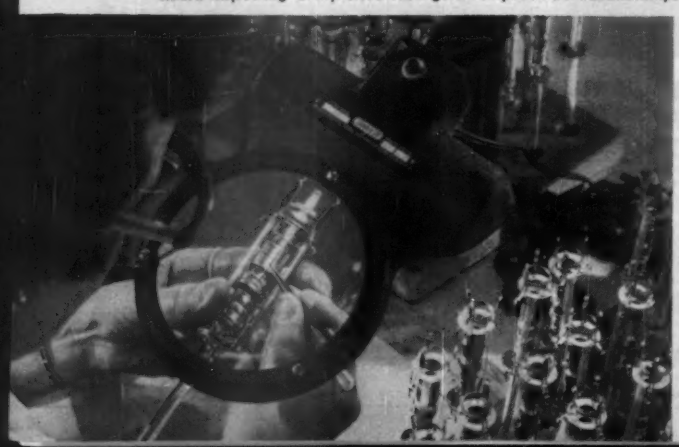
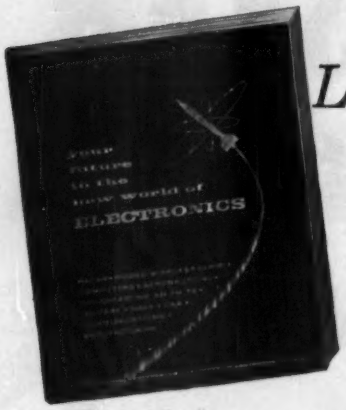
Micro-inspecting G-E picture tube guns for precision workmanship.



100% testing: one reason why G-E Black-Daylite picture tubes are superior.



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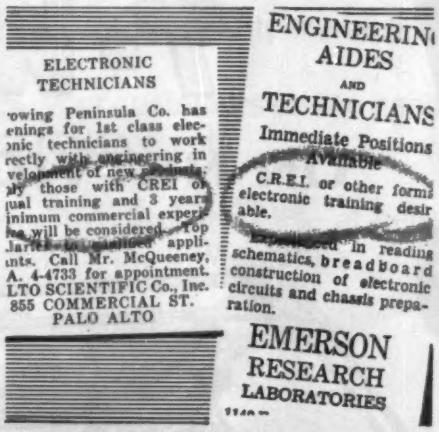
This book, "Your Future in the New World of Electronics," also shows you how CREI Home Study leads the way to greater earnings in the booming electronics world.

However, CREI does not promise you a "snap." With accredited technical school curricula such as CREI offers, you must study to convert your ambition into technical knowledge which you can sell in the fabulous field of Electronics. Since its founding in 1927, CREI has provided thousands of professional electronics men with technical education. During World War II, CREI trained thousands for the Armed Services. Leading firms recommend CREI training for their own personnel. Among them: United Air Lines, Canadian Broadcasting Corporation, Trans-Canada Airlines, Douglas Aircraft Co., The Martin Co., Columbia Broadcasting System, All-American Cables and Radio, Inc., Gates Radio Co., Canadair, Ltd., Federal Electric Corp., and U.S. Information Agency (Voice of America).

CREI courses are prepared by recognized experts, in a practical, easily understood manner, and constantly revised to meet the new electronic challenges of our time. You get the benefit of time-tested study assignments under the personal supervision of a CREI staff instructor. Your studies are accomplished on your own time, during hours selected by you, and controlled by your own willpower. This complete training is the reason that graduates find their CREI diplomas keys-to-success in even the most advanced of electronic applications. CREI alumni hold top positions in America's leading firms. At your service is the CREI Placement Bureau, which maintains constant contact with electronic industry, and cooperates with employers and graduates in making satisfactory placements. This free service is available to students, as well as graduates. Fill out the coupon below *completely* and mail it now. We'll promptly send you your free copy of "Your Future in the New World of Electronics." The rest—you future—is up to you!


ELECTRONIC TECHNICIANS

owing Peninsula Co. has enings for 1st class electonic technicians to work rectly with engineering in velopment of new products. ply those with CREI or ual training and 3 years inimum commercial experi e will be considered. Top larities to qualified appli nts. Call Mr. McQueeney, A. 4-4733 for appointment. LTO SCIENTIFIC Co., Inc. 855 COMMERCIAL ST. PALO ALTO

ENGINEERIN AIDES AND TECHNICIANS

Immediate Positions Available

C.R.E.I. or other forms electronic training desir able.

Experienced in reading schematics, breadboard construction of electronic circuits and chassis preparation.

EMERSON RESEARCH LABORATORIES

CREI ALSO OFFERS residence training in Washington, D. C. . . . at the same high technical level. Day and evening classes start at regular intervals. Qualified residence school graduates earn degree as "Associate in Applied Science." If you have had a high school education, and experience in electronics—you can qualify for CREI home study training. (Electronics experience is not required for admission to CREI Residence School.) Check coupon if you prefer residence or home study information . . . or write Capitol Radio Engineering Institute, Dept. 1112-E, 3224 - 16th St., N.W., Wash. 10, D. C.

INDUSTRY CALLS FOR CREI TRAINING BY NAME . . . SO SHOULD YOU!

Here you see actual help wanted ads—one from a San Francisco newspaper, another seen in Washington. They are just two of many which specify, "CREI or equal" education. This shows that industry approves CREI training, even insists on it. Experience has taught many, many companies that CREI students are taught what industry needs and wants them to know. Let this be your cue when you choose your educational program.

BRAND-NEW COURSE ADDED . . . AUTOMATION AND INDUSTRIAL ELECTRONICS ENGINEERING TECHNOLOGY. Complete course, covers all phases of automation. Special emphasis on theory, functioning, and applications of servomechanisms and computers. Also noteworthy: Lessons on machine control, instrumentation, data-processing, and telemetry.

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ECPD Accredited Technical Institute Curricula—Founded 1927
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Please send me your course outline and FREE illustrated Booklet, "Your Future in the New World of Electronics" . . . describing opportunities and CREI Home Study courses in Practical Electronic Engineering Technology.

CHECK FIELD OF GREATEST INTEREST

- ☐ Radar, Servo and Computer Engineering Technology
- ☐ Electronic Engineering Technology
- ☐ Broadcast (AM, FM, TV) Engineering Technology
- ☐ Television Engineering Technology
- ☐ Aeronautical Electronic Engineering Technology
- ☐ Automation and Industrial Electronics Engineering Technology

B1

Name..... Age.....

Street .....

City ..... Zone..... State.....

Check: ☐ Home Study ☐ Residence School ☐ Korean Veteran

To help us answer your request intelligently, please give the following information:

Employed By.....

Type of Present Work.....

Education:
Yrs. High School.....

Other.....

Electronics Experience.....

CHANNEL MASTER
Sells Antenna

Dave Garroway
TEAMS UP WITH THE
T-W
ON NETWORK TV

One of America's most persuasive TV personalities is now telling his tremendous audience— from coast to coast— all about the world's most powerful television antenna

on the "TODAY" show over the entire NBC-TV Network

AD BLITZ
Replacements

New
CHANNEL MASTER Campaign
in America's Largest
Circulation Magazines...

Puts new **LIFE** into your antenna business

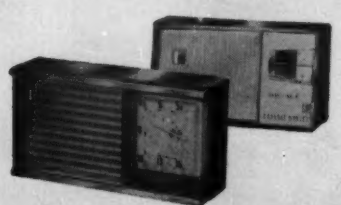
POSTS your customers on the need for antenna replacements

Gives set owners a **LOOK** at better reception with the T-W antenna

GUIDES prospects to your door for an antenna check-up

Helps you **FARM** fertile new fields of antenna profits

and now
CHANNEL MASTER
TRANSISTOR RADIOS



America's #1
RADIO Value

STEP-UP TO STEREO . . . ON A BUDGET

with Stereo's Standard

STEREO'S STANDARD

IF THIS IS YOUR PRESENT or PROPOSED SPEAKER SYSTEM

costing between **$60-$90**

Includes an 8" coaxial speaker such as:
E-V CORONET* (with SP8B), Net $65
E-V BARONET* (with SP8B), Net $74.50
SP8B: Wide range, economical, super-efficient coaxial speaker. Small high-frequency propagator insures fine dispersion.

costing between **$90-$120**

Includes a two-way separate system such as:
E-V CORONET IA, Net $102
E-V BARONET III, Net $111.50
E-V REGAL IA, Net $103

costing between **$120-$140**

Includes three-way speaker such as:
E-V MARQUIS* (with 12TRXB), Net $129
E-V ARISTOCRAT* (with 12TRXB), Net $138
12TRXB: Has all the features of the SP12B—plus a separate high-frequency driver with electrical crossover for still lower distortion. Gives widest spread of vital stereo range to achieve large stereo listening area.

costing between **$140-$200**

*E-V systems which can be expanded with E-V Building Blocks whenever your budget permits.

All E-V enclosures also available in lined oak or walnut finishes.

STEP ONE

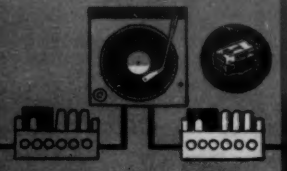
You need the totally compatible E-V STEREO CARTRIDGE

- the first stereo cartridge
- the only field tested stereo cartridge

Thousands already in use prove it

- Plays ALL RECORDS BETTER
  Unexcelled for stereo; superior even to your present cartridge for monaural.
- Highest vertical and horizontal compliance
  For superior tracking, longest record wear
- Best channel separation
  over 20 db between channels
- Flattest response
  Flat beyond audibility to RIAA curve
- Hum and rumble far below any magnetic cartridge
- Two ceramic elements deliver precise RIAA curve with no hum!
- Exclusive E-V Built-In Vertical Rumble Suppressor allows record changer use for stereo
- .7-mil replaceable (diamond or sapphire) stylus is the ideal size . . . gives you better reproduction, longer record wear

Then choose a second amplifier and pre-amplifier. If this is your initial high fidelity system, start with any stereophonic dual amplifier-preamplifier. Play monaurally until you add a second speaker for stereo.



The E-V Totally Compatible Stereo Cartridge is the industry's standard. Choose the model to fit your needs:

MODEL 21D—Stereo with .7-mil Diamond Stylus, Net $19.50

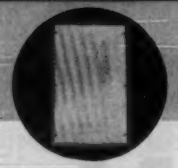
MODEL 26DST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

or the E-V Velocity Stereo Cartridge

MODEL 21MD—Stereo with .7-mil Diamond Stylus, Net $19.50

MODEL 26MDST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

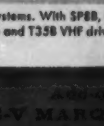
STEP TWO



Add-on E-V BARONET*...
smallest folded-horn corner enclosure for best musical balance and response range: phenomenal bass range; extended two full octaves. Matches the Coronet and other comparable speaker systems. With SP8B, Net **$74.50**, or BARONET III with SP8B and T35B VHF driver, Net **$111.50**

OR

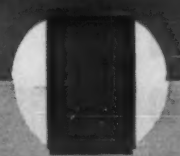
Add-on the new E-V CORONET*...
true, balanced high fidelity reproduction in extremely small economical space-saving form: only 10 inches of wall space required. Complements Aristocrat, Marquis, Baronet or



...tem. With SP8B 8-inch speaker, response down to 70 cps., Net $65.00 or add-on CORONET IA with SP8B and T35B VHF driver, $102.00, or add-on REGAL IA, Net $103

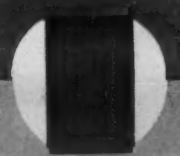
OR

Add-on E-V ARISTOCRAT*...



popular folded-horn corner enclosure . . . compact, economical . . . delivers most extended bass range for its size. With SP12B, Net **$107.00**; with 3-way 12TRXB, Net **$138**

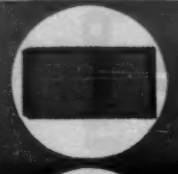
Add-on E-V MARQUIS*...



matching along-the-wall counterpart of the popular Aristocrat. Response down to 40 cps. With SP12B, Net **$98.00**; with 3-way 12TRXB, Net **$129**

OR

Add-on STEREON IA
The all-new Electro-Voice speaker system that solves your space problem—saves you money. Where space doesn't permit you to add a second full-range speaker, a Stereon is the answer. It's compact, because the Stereon reproduces only those frequencies needed for stereo. Bass below 300 cps does not contribute to the stereo



Add-on E-V REGAL IA
super-compact, specially designed system with selected components to give enhanced range and purity of tone with least loss of efficiency. Can be used with high-powered amplifier. Net $147.50

Systems shown are but a few of the multitude of E-V combinations found in every price class. Ask your dealer or write Electro-Voice for information on the industry's most complete line of high fidelity speakers and enclosures.

Electro-Voice®

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN

Pioneer in Electro-Acoustics: Microphone, Phono Cartridge, High-Fidelity Loudspeaker and Enclosure, Public Address Speakers, Marine Instruments, EVI Professional Electronic Instruments and Military Mfg.

All E-V enclosures also available in limed oak or walnut finishes.

MODEL 24MDST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

complete line of high fidelity speakers and enclosures.

step UP your speaker system with ELECTRO-VOICE BUILDING-BLOCK KITS

first, choose an acoustically-perfect Electro-Voice factory-assembled enclosure or a do-it-yourself enclosure kit

E-V Aristocrat net $72
E-V Aristocrat KD6 Kit net $39
or its along-the-wall counterpart the new E-V Marquis net $63

E-V Regency net $130
E-V Regency KD4 Kit net $73
E-V Empire net $99
E-V Empire KD5 Kit net $51

second, choose an Electro-Voice full-range coaxial two-way speaker

SP8B net $29.50 | SP12B net $35 | SP12 net $46 | SP15B net $43 | SP15 net $89

STEP ONE add-on an Electro-Voice high-frequency Building-Block Kit for a separate two-way system

BB1 BUILDING-BLOCK KIT includes T35B Super-Sonax VHF Driver, X36 Crossover, AT37 Level Control, Wiring Harness. net $37

BB2 BUILDING-BLOCK KIT includes T35 Super-Sonax VHF Driver, X36 Crossover, AT37 Level Control, Wiring Harness. net $50

BB1 BUILDING-BLOCK KIT net $37 | BB2 BUILDING-BLOCK KIT net $50

or start with an Electro-Voice integrated three-way speaker (equivalent to coaxial plus high-frequency driver)

12TRXB net $66 | 12TRX net $125 | 15TRXB net $79 | 15TRX net $147

STEP TWO add-on an Electro-Voice mid-range Building-Block Kit for a separate three-way system, the ultimate in high fidelity reproduction

STEREO'S STANDARD

BB3 BUILDING-BLOCK KIT includes T10A Driver, 8HD Horn, X825 Crossover, AT37 Level Control, Wiring Harness . . . . . net $86

BB4 BUILDING-BLOCK KIT includes T25A Driver, 8HD Horn, X8 Crossover, AT37 Level Control, Wiring Harness . . . . . net $114

BB3 BUILDING-BLOCK KIT includes T10A Driver, 8HD Horn, X825 Crossover, AT37 Level Control, Wiring Harness . . . . . net $86

BB4 BUILDING-BLOCK KIT includes T25A Driver, 8HD Horn, X8 Crossover, AT37 Level Control, Wiring Harness . . . . . net $114

Picture your speaker system with E-V Building-Block Kits.* You can start with a single, full-range Electro-Voice Loudspeaker and expand it step-by-step to a multi-way system as your budget permits.

Electro-Voice enclosures are ready for future addition of high-frequency and mid-range speakers. Your E-V enclosure can never be obsolete because there's *always* room to expand your system.

***E-V Building-Block Kits may also be used with some non-E-V quality systems. Ask your high fidelity specialist or write Electro-Voice for details.**

Two ways to a Separate Three-Way System

1. Start with an Electro-Voice full-range coaxial speaker. Then, when your budget permits, add-on the correct E-V high-frequency Building-Block Kit to give you a *separate* two-way system; later add-on the E-V mid-range Building Block Kit for a superlative *separate* three-way system.

2. Or, begin your system with an E-V integrated 3-way speaker; merely add-on the E-V mid-range Building-Block Kit to achieve a *separate* three-way system.

***Of course,* you can purchase a *complete* three-way system composed of low-frequency driver, high-frequency driver BB Kit, and mid-range driver BB Kit.**

Electro-Voice®

FOREMOST IN ELECTRO-ACOUSTICS—Microphones, Phono Cartridges, High Fidelity Loudspeakers and Enclosures, Public Address Speakers, Marine Instruments, EVI Professional Electronic Instruments and Military Material
ELECTRO-VOICE, INC., Buchanan, Michigan

Electro-Voice has the industry's most complete and versatile line of speakers, enclosures, and kits. Ask your high fidelity dealer or write E-V for complete information on how to step-up your system.

Within the Industry

LINDSEY R. PERRY has been appointed product manager, special purpose tubes and high-fidelity components for *CBS-Hytron*, electronic manufacturing division of *Columbia Broadcasting System, Inc.* He was formerly manager, production planning and control, for the entire organization.

Mr. Perry joined the company in 1949. During the development of color TV picture tubes he was assigned to the cathode-ray tube research and development laboratory. He later became production superintendent for the firm's "Colortron" manufacturing operations, and in 1956 was made manager of the TV picture tube plant in Newburyport, Mass.

Mr. Perry is a graduate of MIT.

* * *

WEST COAST ELECTRONIC MANUFACTURERS ASSOCIATION (WCEMA) has formed a new council.

The "North-West" Council was formally recognized and consists of firms in the greater Portland and Seattle areas. Serving as officers are: Lawrence R. Rockwood, vice-president of *Electro-Measurements, Inc.*, chairman; Ray Dilling, vice-president of *Tally Register Corp.*, Seattle, vice-chairman; and Bill Webber, vice-president administration, *Tektronix, Inc.*, Portland, vice-chairman. Mr. Rockwood automatically becomes a WCEMA vice-president and director.

Nucleus of this new Council is: *Electro-Measurements, Inc.; John Fluke Mfg. Co.; Osborne Electronic Corp.; Tally Register Corp.; Tektronix, Inc.; Iron Fireman-Electronic Div.;* and *Morrow Radio Mfg. Co.* Some fourteen other electronic firms are expected to actively participate.

* * *

DONALD H. KUNSMAN has been appointed president of the *RCA Service Company*, a division of the *Radio Corporation of America.*

Mr. Kunsman joined the firm in 1949 as an assistant to the president and has held various management positions including treasurer and controller; vice-president, consumer products service department; and vice-president and operations manager. In the last position, which he assumed in July, 1957, he has been responsible for all service and sales functions.

Mr. Kunsman succeeds Edward C. Cahill who headed the firm since its inception in 1943.

* * *

ROBERT E. SVOBODA, distributor sales manager of *Amphenol Electronics Corp.*, has been elected first vice-president of the Association of Electronic Parts & Equipment Manufacturers, Inc.

Irving Rossman, president of *Pentron Corp.*, has been elected second vice-president of the association.

* * *

HENRY B. NELSON, JR., has been appointed manager of trade relations and electronic components distributor development for the *General Electric Co.*

Since 1952 Mr. Nelson has been district sales manager for tubes and other electronic components sold to distributors in Ohio, West Virginia, and Kentucky.

In his new position he will be responsible for maintaining liaison with more than 300 trade associations and developing new sales training programs and techniques in distributor and dealer operations.

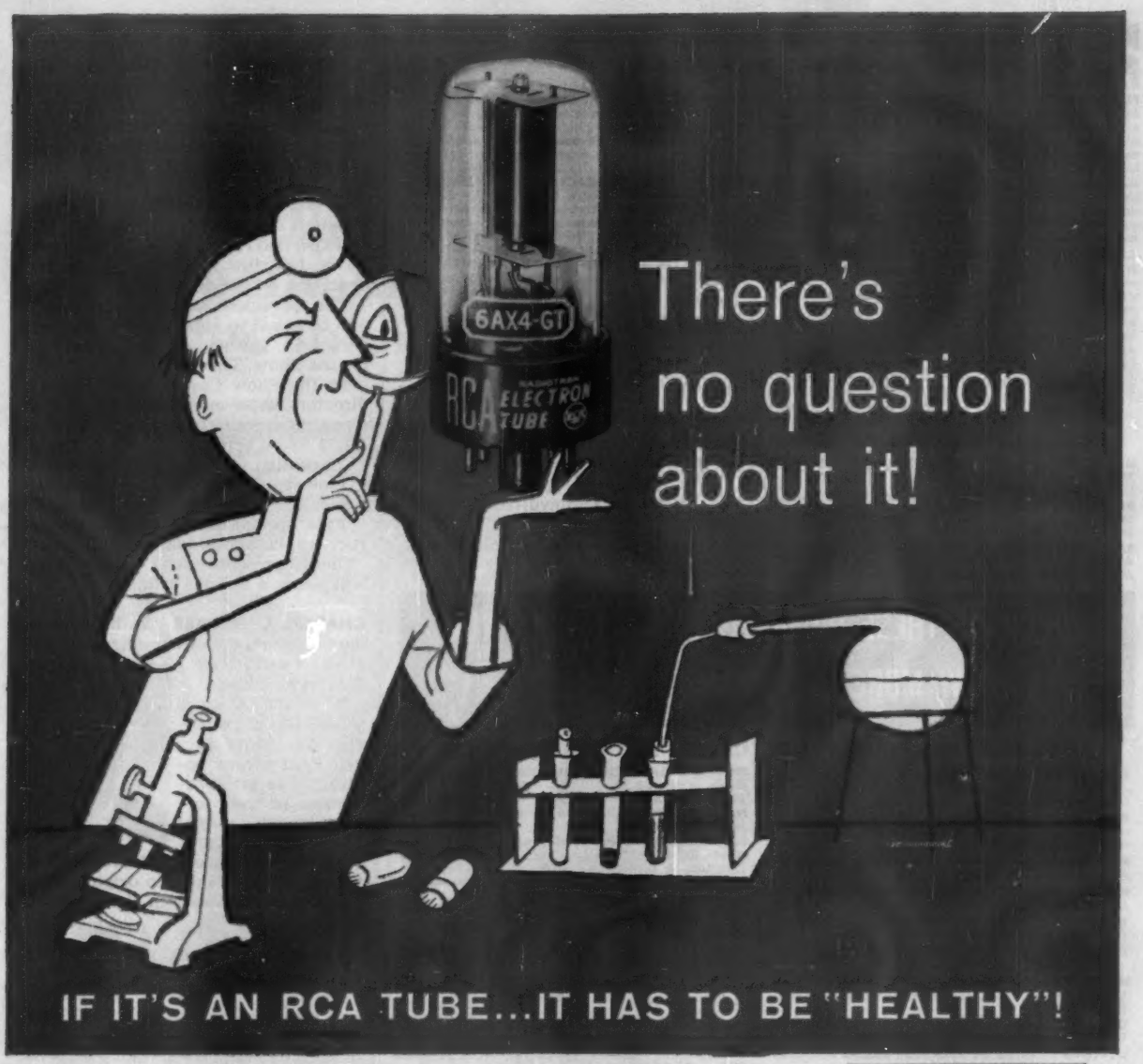
* * *

ELECTRONIC INDUSTRIES ASSOCIATION has accepted thirteen additional firms for membership.

The companies are: *Aeronutronic Systems, Inc.*, Glendale, Calif.; *Amco Engineering Co.*, Chicago, Ill.; *Columbus Electronics Corp.*, Semiconductor Div., Yonkers, N. Y.; *Continental Illinois National Bank & Trust Co.*, Chicago, Ill. (associate member); *The Martin Co.*, Baltimore, Md.; *Master Mobile Mounts, Inc.*, Los Angeles, Calif.; *Resistron Laboratories, Inc.*, Santa Monica, Calif.; *The Siegler Corp.*, Los Angeles, Calif.; *SNC Manufacturing Co., Inc.*, Oshkosh, Wisc.; *Syncro Corp.*, Electronics Div., Hicksville, Ohio; *U. S. Semiconductor Products, Inc.*, Phoenix, Ariz.; *United Transformer Corp.*, New York, N. Y.; and *Wyco Metal Products*, North Hollywood, Calif.

* * *

THE GABRIEL COMPANY proposes to acquire the **TALCO ENGINEERING CORPORATION** of Mesa, Arizona. The parent company will take over all of the assets of its subsidiary . . . **COMPUTER EQUIPMENT CORP.** is the new name of the company formerly known as **DIGITRON, INC.** The name change was effected in order to clarify the nature of the business in which the firm is engaged . . .



RCA *specializes* in the production of *"healthy"* tubes. Take the RCA-6AX4-GT, for example. It features important built-in safety factors that minimize internal breakdowns and "arc-over", reducing early-hour failures—while providing reliable performance in TV damper circuits. Here are some of the ways RCA builds this "good health" into the 6AX4-GT:

Heater wire has been specially developed to improve welds, thereby reducing early-hour failures due to an open circuit at the weld point. Heater-spacer assemblies are pre-fired to eliminate leakage-producing contamination during tube production. And micas are specially sprayed to control plate-to-cathode leakage.

These are some of the reasons why many designers and manufacturers of TV sets specify RCA's 6AX4-GT—the very same reasons why you should always ask your RCA Tube Distributor to *"Ship RCA Only"!*

RCA Technical Booklet Available

RCA Receiving Tubes and Picture Tubes for AM, FM, and Television Broadcast (1275-H) . . . includes socket information and useful data for more than 700 tube types. Ask your RCA Tube Distributor for your copy today!

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. J.*

BECKMAN INSTRUMENTS, INC. announces formation of the **SHOCKLEY TRANSISTOR CORPORATION** as a subsidiary company to expand development and manufacture of specialized semiconductor components for electronic instruments, communications equipment, and control systems.

* * *

"THE REPRESENTATIVES" of Electronic Products Manufacturers, Inc. will have an expanded role in the 1959 Electronic Parts Distributors Show to be held next May in Chicago.

The president of the organization will be asked to appoint from the membership a special advisory committee for the Show. This committee will work with the Show Corporation's board of directors, show management, and Show Corporation committees on all 1959 Parts Show activities.

Eligibility for "Rep" badges will be extended to all individuals whose companies are members of this group.

Also, special badges will be issued to registrants whose companies belong to "The Representatives." These badges will carry a special insignia.

* * *

CHARLES L. McCABE has been named manufacturers' sales manager of *Shure Brothers, Inc.*, Evanston, Illinois.

Mr. McCabe joined the organization five years ago. His most recent position was staff assistant to the vice-president in charge of sales.

In his new capacity Mr. McCabe will be in charge of sales to original equipment manufacturers in the electronics field.

* * *

JOHN M. LESLIE, JR. has been named general manager of *ORRadio Industries, Inc.* . . . **WALTER F. GREENWOOD** has been appointed manager of marketing for *General Electric's* receiving tube department . . . Two new managers have been named to *Raytheon Manufacturing Company's* receiving tube division. They are: **JOSEPH J. GRABIEC,** marketing manager; and **GEORGE LOOMIS,** manufacturing manager . . . The *RCA* semiconductor and materials division has appointed **ERWIN B. MAY** as manager of promotion . . . **DAVID PETRIG** is now chief engineer of the manufacturing division of *ORRadio Industries, Inc.* . . . The appointments of **DONALD F. WENTZLER** as director of planning and organization and **EDWARD J. FELESINA** as director of public relations and advertising at *ITT Laboratories* has been made known. The firm is a division of the *International Telephone and Telegraph Corp.* . . . *Michigan Magnetics, Inc.* announces the appointments of **GORDON E. PARKER** as production manager for the Vermontville, Michigan plant and **JACK L. METZ** as chief research engineer . . . **WILLIAM BROWN** is now manager of sales for *Magnetic Research Corp.* . . . *Admiral Corp.* has appointed **WILLIS L. WOOD** as national

(*Continued on page* 114)

SYLVANIA TV

has always stood behind the independent service man!

Recently, a spokesman for the Federation of Radio-Television Service Associations of Pennsylvania cited SYLVANIA TV as one of two TV manufacturers whose policies "have been favorable to the independent service industry."

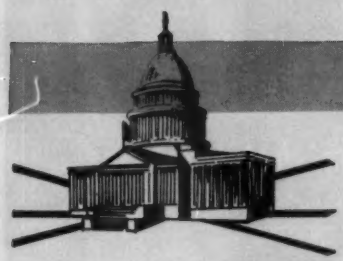
In 1956—Robert L. Shaw, General Marketing Manager, SYLVANIA TV Division said:

"We have never expressed an intention of going into factory service at the local level and it is not our intention to do so. We feel that the local factory service is justified only when distributors, dealers and independent servicemen fail to meet the demands of the public. We see *no evidence* of such failure and have no intention of entering the factory service field."

Released for publication Dec. 5, 1956.

SYLVANIA has never felt the need to change this long established policy. SYLVANIA will continue to rely on independent distributors, dealers and accredited independent servicemen for post-factory service.

Recommend SYLVANIA TV—
the line that supports the independent serviceman



Latest Information on the Electronic Industry

Spot News

By RADIO & TV NEWS' WASHINGTON EDITOR

U.S. INFORMATION AGENCY CREATES OVERSEAS TV SERVICE—In keeping with the increasing importance of TV for reaching foreign audiences with the American story, the U.S. Information Agency has set up a separate television service and appointed Romney Wheeler, formerly with NBC, as director . . . Some 560 television stations overseas, 458 of them outside the Iron Curtain, and more than 20-million TV receivers outside the U.S. and Canada, will transmit and receive documentary films, special events coverage, and features which depict various aspects of American life.

OVER ONE-QUARTER OF H.F. SPECTRUM NOW USED BY GOVERNMENT—A recent analysis of radio-spectrum usage between 25 and 960 mc. has revealed that 25.7% is allocated to the Federal government, 1.7% to public safety, 4.4% to travel safety, 2.3% to commercial, 5.2% to research and development, .5% to public correspondence, .7% to personal convenience, and 59.5% for education and entertainment.

TOP INCOME SET FOR ELECTRONIC ENGINEERS IN ALASKA—Life for electronic engineers in the new state of Alaska has several attractions, one of them being higher pay, according to the Civil Aeronautics Administration . . . Under Civil Service rules, engineers on the Alaskan payroll may be started at pay steps higher than other employees, because of the need for experienced hands in the electronics fields. They can begin at a salary of $4490 to which is added $1125 as a tax-free territorial cost of living allowance. Each additional year $1000 is added. Top engineer grade (GS-14) starting salary is $11,595 with a $2898 living allowance.

U.H.F. TV CHANNEL AGREEMENT REACHED BY U.S. AND MEXICO—An agreement concerning the allocation of 70 u.h.f. channels (14-83), at locations of 200 miles along the common border, has been formalized. Tables included in the agreement contain specific assignments for 60 Northern Mexican and 83 Southwestern American cities.

AIR FORCE STUDYING VALUE OF AUDIO SIGNALS FOR WEAPON-WARNING SYSTEMS—An evaluation of the merits of audio signals as warning indicators to relieve overloading of visual requirements in weapon systems is under survey by the U.S. Air Force. Problems areas being reviewed involve the determination of the criticality of events, human and equipment characteristics and their relation to audio-warning displays, and task dimensions essential to the evaluation of audio-warning displays.

ELECTRONIC NAVIGATION MAP TECHNIQUE DEVISED—A precise navigational system that can draw air lines automatically on electronically controlled maps has been developed and is being probed by the Airways Modernization Board as an aid in helicopter flight. The system, called the Bendix-Decca Navigator, is a low-frequency navigational aid. Position lines are transmitted by stations and picked up by receivers; information is then computed and displayed on decometers, or indicators, and on flight maps. Maps consist of a chart of the area being covered, with all of the ground obstacles indicated on it. A moving stylus tracks the position of the helicopter on the chart.

CITIZENS RADIO LICENSE FORM REVISED—The FCC has adopted a revised Citizens Radio Service Form (505) which asks for a statement as to the manner in which the station will be used in connection with the applicant's business or personal activities and a certification by the applicant to the present rule requirements that the station will not be used for any purpose contrary to Federal, state, or local law. All applications in the Citizens Radio Service must now be filed in Washington.

MOVE TO SET UP HI-FI DEFINITIONS SHELVED BY WASHINGTON—Indefinite postponement of a high-fidelity trade-rule program has been indicated by the Federal Trade Commission. Spokesmen have disclosed that a number of hi-fi definitions have been submitted and in every instance objections to the definitions have been filed with the FTC. Accordingly, it was said, the formal rule plan will be shelved until industry can arrive at a basis for agreement. -30-

THIS IS IT!

a NEW stereo speaker system that combines...

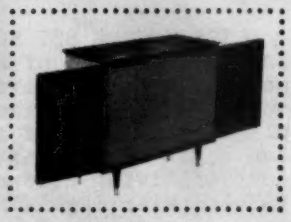
- Unprecedented compactness - only 30"wide, 25"high, 12½"deep
- A third dimension to stereo sound ... DEPTH
- Placement anywhere in a room
- Use for both monophonic and stereophonic reproduction
- Uncompromised quality at an attractive price

"Now, I must tell you, I have heard a speaker system that approaches the authenticity of concert hall performance."

MISCHA ELMAN

Now celebrating the 50th anniversary of his American debut, acclaimed throughout the world for his supreme virtuosity... internationally celebrated violinist Mischa Elman is an artist whose preference for concert hall performance over recorded music is a matter of public record. His enthusiasm after hearing the TMS-2 in his home is shared by many other leading artists, musical authorities and audio experts who also subjected the TMS-2 to critical listening tests under at-home conditions.

PATENT APPLIED FOR



The TMS-2 with deflector doors opened for full stereo reproduction.

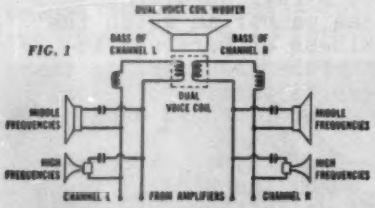
Here the TMS-2 is shown with deflector doors closed for monophonic use.

University's NEW 'trimensional' stereo speaker TMS-2

Here is the most significant loudspeaker achievement since the advent of popular stereo ... a University development which, at last, actually eliminates *all* the problems of placement, space limitations, decor and cost ... but most important of all, produces a new kind of stereo sound ... the authenticity of concert hall *depth*.

COMPACT By utilizing the exclusive *dual voice coil* feature of the C-12HC woofer, only one bass enclosure and woofer are required to handle the entire low frequency range of both stereo channels. Extended, undistorted bass is superbly reproduced by making use of the RRL enclosure design so successfully employed in University's Ultra Linear Response systems. *See fig. 1.*

FIG. 1



REALISTIC STEREO The breadth, depth and clarity of stereophonic sound is accomplished by utilizing the walls of a room, just as the symphony orchestra uses the acoustical properties of the concert hall. The woofer sound emanates at the rear of the enclosure; one mid-range and one high frequency speaker for each channel project sound from each side of the cabinet. By thus deflecting all frequencies, in proper relationship, to the rear and side walls of the room, multiple stereo sound sources are created that not only provide the otherwise missing dimension of depth, but also preserve the stereo effect virtually throughout the room. *See fig. 2.*

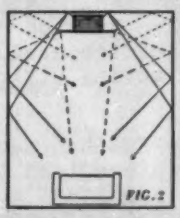


FIG. 2

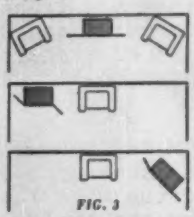


FIG. 3

USE ANYWHERE The unique design of the TMS-2 provides you with two distinct advantages: place it in a corner or *anywhere* along a wall, by merely positioning the deflectors as shown in fig. 3, and since there are *no particularly critical listening positions*, you, your family, your friends—any number of listeners—can enjoy the TMS-2 from most anywhere in the room.

MONOPHONIC OR STEREOPHONIC With deflectors closed, the TMS-2 is an outstanding, wide-range monophonic speaker system. "Presence" and "brilliance" controls are provided for both sets of mid and high frequency speakers. In addition to being used for balancing the system to room acoustics and personal taste, these controls and the deflectors may be adjusted to produce a pseudo-stereo effect with monophonic program material as well. Whether you start your high fidelity system with monophonic equipment, or go right into stereo, the TMS-2 is the best investment you can make... it is equally "at home" with any kind of program material, and *no further additions* to the speaker system are ever required.

DESIGNED RIGHT - PRICED RIGHT Flawlessly designed along simple, classical lines, beautifully proportioned to compliment the most exacting taste, the TMS-2 will enhance any decor. In fact, it looks more like a piece of fine furniture than a typical speaker cabinet. Breathtaking in its performance ... beyond the scope of conventional monophonic or stereophonic reproduction, the engineering concept of the TMS-2 eliminates redundant components; makes use of the latest, most advanced acoustic principles. **RESULT:** the ultimate in uncompromised value. *In Mahogany —$258, Blonde or Walnut—$263, User Net.*

See and hear the TMS-2 at your dealer ... NOW! You too, will agree with musical and audio experts that it marks one of the most extraordinary advances in high fidelity and stereo history!

University

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the specs prove it . . your BEST BUY is EICO®

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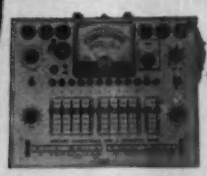


NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (and picture tubes with adapter). **Composite indication of Gm, Gp & peak emission. Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensitivity** (1% shunts & 5% pot). **10 SIX-position lever switches:** freepoint connection of each tube pin. **10 pushbuttons: rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. **CRA Adapter $4.50**

New!

Series/Parallel R-C COMBINATION BOX #1140

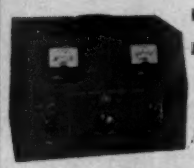
KIT $13.95 WIRED $19.95

TUBE TESTER #625

KIT $34.95 Wired $49.95

- tests 600 mil series string type tubes
- illuminated roll-chart

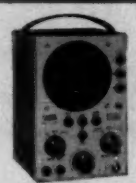
Pix Tube Test Adapter $4.50



6V & 12V BATTERY ELIMINATOR & CHARGER #1050

KIT $29.95 WIRED $38.95

Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95



New!

Miniaturized MULTI-SIGNAL TRACER #145A

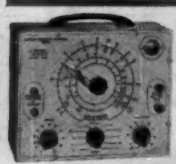
KIT $19.95 WIRED $28.95

20,000 Ohms/Volt V-O-M #565

KIT 24.95 Wired $29.95

1000 Ohms/Volt V-O-M #536

KIT $12.90 Wired $14.90



Reads 0.5 ohms —500 megs, 10 mmfd—5000 mfd, power factor.

KIT $19.95 Wired $29.95

R-C BRIDGE & R-C-L COMPARATOR #950B

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
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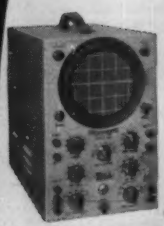
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

NEW! COLOR and Monochrome DC to 5 MC LAB & TV 5" OSCILLOSCOPE #460



KIT $79.95 WIRED $129.50

- **Features DC Amplifiers!**

Flat from DC-4.5 mc, usable to 10 mc. **VERT. AMPL.:** sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull **thruout;** K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. **SWEEP:** perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); **preset TV V & H positions;** auto. sync. ampl. & lim. **PLUS:** direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

5" PUSH-PULL Oscilloscope #425: Kit $44.95, Wired $79.95.
7" PUSH-PULL Oscilloscope #470: Kit $79.95, Wired $129.50.

NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased **incremeter** for excellent linearity. **Extremely flat RF output:** new AGC circuit automatically adjusts osc. for max. output on each band with min. ampl. variations. Exceptional tuning **accuracy:** edge-lit hairlines eliminate parallax. **Swept Osc. Range** 3-216 mc in 5 fund. bands. **Variable Marker Range** 2-75 mc in 3 fund. bands; 60-225 mc on harmonic band. **4.5 mc Xtal Marker Osc., xtal supplied.** Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. **6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%;** 6:1 vernier tuning & excellent spread at most important alignment freqs. **Etched tuning dial,** plexiglass windows, **edge-lit hairlines.** Colpitts RF osc. **directly plate-modulated by K-follower for** improved mod. **Variable depth of int. mod. 0-50%** by 400 cps Colpitts osc. **Variable gain ext. amplifier:** only 3.0 v needed for 30% mod. **Turret-mounted coils slug-tuned** for max. accuracy. Fine & Coarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5-way jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

NEW! PEAK-to-PEAK VTVM #232 & UNI-PROBE (pat. pend.)

KIT $29.95 WIRED $49.95

Half-turn of probe tip selects DC or AC-Ohms.

Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide ranges & versatility. **Calibration without removing from cabinet.** New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. **7 non-skip ranges on every function.** 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. **Zero center.** One zero-adj. for all functions & ranges. **1% precision** ceramic multiplier resistors. Measure directly peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

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SEE OUR ALMO'S "HAM" ADVERTISEMENT ON PAGE 142

The Silicon —Solar— Battery

By HAROLD S. RENNÉ

This solar battery is used to supply power to terminal equipment on rural phone lines.

Will our future electricity all come from the sun? Here's a way of tapping a small bit of sun power.

NOW that "Vanguard I" is traveling merrily around in its orbit, with its solar-battery-powered radio transmitter, interest in solar batteries has risen to a new high. There is a chance that this transmitter and the solar batteries will continue to operate as long as the satellite remains aloft—which has been variously estimated at up to 200 years or possibly longer.

The silicon solar battery was announced by *Bell Telephone Laboratories* in April, 1954 and since then has become widely known as the *Bell* Solar Battery. It was employed to power a rural carrier-telephone system in Americus, Georgia for a period of time and carried out this task with flying colors. However, because of its cost, it was not considered competitive with other more conventional sources of power. Now, however, cells are being manufactured by *Hoffman Electronics Corp.'s* Semiconductor Division and by *International Rectifier Corp.* at prices which make them highly attractive for experimental purposes and perhaps even for some commercial applications.

Available Power

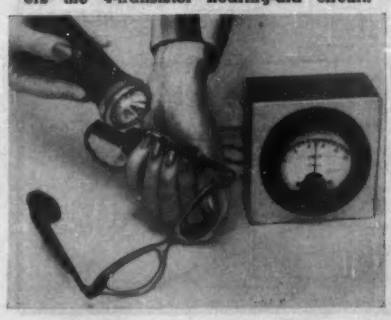
How much power can be obtained from a solar battery? The answer to this question depends primarily on two factors—the intensity of the radiation striking the cell and the efficiency of the cell. It has been established that the energy falling on one square meter of the earth's surface in Phoenix, Arizona at high noon is approximately 1000 watts—truly an appreciable amount of power, if all of it could be harnessed.

Looking at it in another way, the energy reaching the outer atmosphere of the earth amounts to about 3.5 *billion* watts per square mile. The cross-sectional area of the earth is about 50 million square miles, so the total radiation reaching the earth is the fantastic figure of 1.8×10^{17} watts! This figure can be appreciated a little better if we realize that in *40 hours* the sun provides us with as much energy as is available in our *total* oil and gas reserves. Even allowing for atmospheric absorption, energy equivalent to total annual world requirements falls on only 12,000 square miles of land area in Arizona!

The first silicon solar cells built at *Bell Laboratories* had an efficiency of about 6% or less. However, this figure has now been nearly doubled and commercially available cells have efficiencies as high as 11% or more. Still higher efficiencies will undoubtedly be obtained as research continues. Thus, with one square meter of surface exposed, a solar battery could produce up to 110 watts of power.

Editor's Note: The silicon solar battery described in this article is not to be confused with the selenium photovoltaic cell which has been in use for a number of years. The selenium cell, although much less expensive than the silicon type, has an efficiency of roughly one-tenth of the silicon cell. Manufacturers of the selenium cell include the General Electric Co. and the International Rectifier Corp.

Silicon solar cells, mounted in the temple bar of the new Zenith eyeglass hearing aid, are shown here producing an output voltage as a flashlight illuminates them. The cells are used to recharge the tiny nickel-cadmium storage battery that powers the 4-transistor hearing-aid circuit.



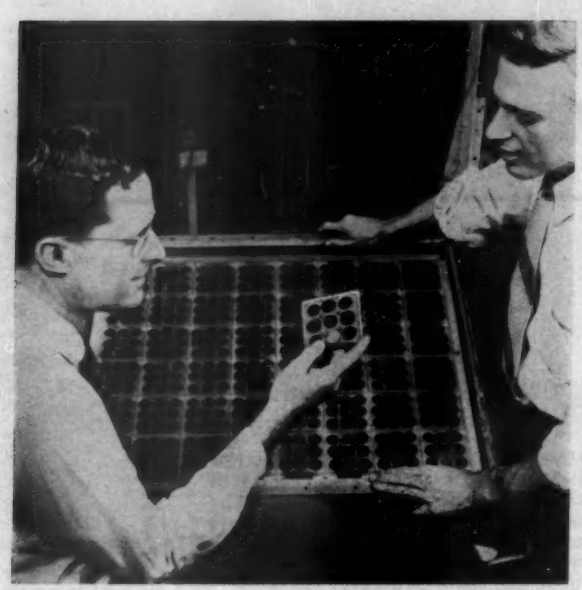
How Does It Work?

How does the silicon solar cell work? To understand its operation, we will review briefly some information about solid-state physics and about *p-n* junctions, as the cell consists primarily of a silicon *p-n* junction.

First let's discuss what is meant by *p*-type and *n*-type silicon. The two types are the same as those employed in silicon transistors—*p*-type means an excess of holes whereas *n*-type refers to an excess of electrons. The two types are obtained by "doping" the silicon, that is, by adding very small, controlled amounts of certain impurities.

A *p-n* junction is just what its name signifies—a junction between *p*-type and *n*-type silicon. Later we will describe how this junction can be formed. Fig. 1 indicates the electrical conditions at a *p-n* junction. An electrical barrier is built up so that the free electrons from the *n* region and the

The power needed to transmit a telephone conversation can now be obtained directly from the sun. In this indoor demonstration, Gerald L. Pearson, one of the co-inventors of the Bell Solar Battery, holds the device under artificial light. Battery shown can achieve efficiency comparable to gasoline engine.



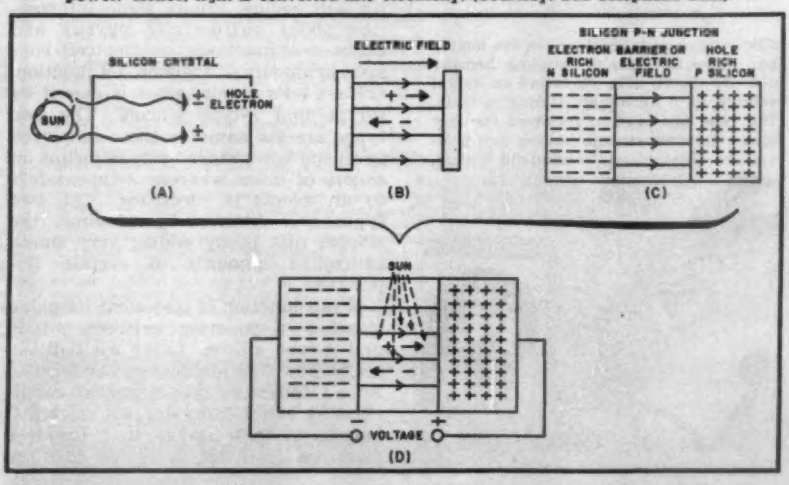
The solar battery is shown here being assembled. The device uses discs of wafer-thin silicon about the size of quarters. Small modules like that in the center are electrically linked together to form the larger 432-cell solar battery. The discs can deliver power at the rate of 100 watts per square yard.

free holes from the *p* region cannot intermix. This electrical barrier, or field, forms the heart of the *p-n* junction. When light strikes this region, some of its energy is utilized to eject an electron from a silicon atom, thus forming a hole-electron pair. The built-in field serves to separate these charges before they can recombine. When such a situation occurs, a potential will develop across the junction and current will flow in an external circuit.

A solar cell consists of a very thin slice of silicon (about 1/25 of an inch thick) cut from a single crystal of *n*-type material, silicon which has been doped with a tiny amount of an impurity such as arsenic. The amount of arsenic required is very minute—perhaps one part in a million. To form the *p*-type material, a small amount of boron or similar impurity is diffused into the surface of this wafer to a depth of about one ten-thousandth of an inch. To carry out this diffusion process, the silicon wafers are heated to about 1200° C in an atmosphere containing boron or a boron compound. The depth to which the boron will diffuse is accurately controllable and is determined by the temperature and the length of time the wafers are exposed.

Following the diffusion process, leads are attached—one to the *n*-layer and one to the *p*-layer. A new process called "thermocompression bonding," recently developed at *Bell Labs*, is ideal for making such attachments. Other techniques such as soldering and plating can also be employed, but to obtain a good, reliable, low-resistance bond requires a considerable amount of skill and experience. Fig. 2 shows the general construction of a typical cell.

Fig. 1. How the solar battery works. (A) Light is absorbed in a silicon crystal by liberating free-to-move negative charges, or electrons—and free-to-move positive charges, called holes. (B) An electric field exerts a force on charge particles causing them to move if they are free. The force moves holes in one direction and electrons in the opposite direction. (C) In a thin barrier at the junction between an electron-rich "n"-region and a hole-rich "p"-region in a silicon crystal, a strong built-in electric field exists which keeps the electrons in the "n" side and holes in the "p" side. (D) When light is absorbed liberating electrons and holes in the barrier region at "p-n" junction, the built-in field forces the holes into the "p" side, making it positive, and the electrons into the "n" side, making it negative. This displacement of the newly freed charges causes a voltage to appear between the ends of the crystal, a voltage that is a source of electric power. Hence, light is converted into electricity. (Courtesy: Bell Telephone Lab.)



Operation

A solar cell in full sunlight will generate an open-circuit voltage of about 0.6 volt. For a cell having an active area of one square inch, a short-circuit current of well over one hundred milliamperes may be produced. Typical characteristics are shown in Fig. 3. By connecting a number of cells in various series-parallel combinations, practically any desired voltage or current can be obtained for any required specific application.

For the Americus, Ga. trial carried out by *Bell Laboratories* a total of 432 cells was employed, made up of 48 9-cell modules. This combination provided an output of about one-half ampere at 22 volts in full sunlight, which was used to charge a nickel-cadmium

storage battery. The battery, in turn, powered the transistorized carrier-telephone equipment.

In an application of this kind, it is necessary to provide some means to prevent the storage battery from discharging through the solar battery during periods of darkness. This is accomplished by connecting a diode in series, so arranged that it has very low resistance when the battery is charging and a very high resistance when it is attempting to discharge through the solar battery. A typical circuit is shown in Fig. 4. If no storage battery is used, the solar battery would be connected directly to the load just like a regular battery. In this case, of course, no current would flow through the load when the cells were not illuminated.

Applications

Most applications of the solar battery to date have been of an experimental nature. For example, *Admiral* built a solar-battery-operated radio which would play in full sunlight without any other source of power. Expense was the principal deterrent to widespread consumer acceptance of this unit. Recently *Hoffman* developed and is marketing a portable which uses a silicon pack of its own manufacture. Also, the Signal Corps has experimented with a portable transmitter powered by a solar battery mounted on the soldier's helmet. All this equipment is, of course, transistorized for low power drain.

A small, transistorized audio oscillator has been made at *Bell Labs* which produces audible oscillations even when illuminated by a relatively dim light. This brings up an interesting point—the solar battery will operate under artificial light, the actual output again depending on the intensity of illumination.

Animated displays are another possible application of solar batteries. *Hoffman Electronics* has built a model of a 4-motor airplane in which the propellers are driven by electric motors which obtain their power from solar batteries. Various other types of window displays are possible and it is likely that such applications will become fairly widespread.

The silicon solar cell is, of course, a photovoltaic cell and as such can be used in exposure meters and the like. Because of its high efficiency, such meters can be made with higher sensitivity and with more rugged meter movements than is possible with previously available cells. Also, it can be adapted to many industrial counting and sorting operations where sensitivity to variations in light intensity is necessary. In counting operations, it can readily follow light interruptions as fast as 50,000 per second.

An interesting possible application was mentioned in a recent *Hoffman* advertisement. Solar batteries could be used to operate runway flashing lights on emergency landing fields. The primary source of power would be

COVER STORY
SOLAR POWERED DISPLAY

OUR MOST inexhaustible and stupendous potential source of energy—the sun—was harnessed to a unique design when Charles Eames created the "Solar Toy," shown on our cover, for the "Forecast Collection" of Aluminum Company of America.

Intrigued by the possibilities of a future where man would use an energy source 93-million miles distant, Eames fashioned a design so that people may "see a living demonstration of the fantastic potential of the work that solar energy can perform for mankind."

The Solar Toy, performing no function in itself, amply demonstrates the potential of the sun as it converts solar into electrical energy to turn wheels, spin crankshafts, and create optical illusions.

Heart of the unit is a bank of silicon solar cells made by International Rectifier Corp. Mounted in a reflector unit, oriented toward the sun by a unique tracking device, the cells are practical photovoltaic devices, capable of directly converting radiant or solar energy into electrical power of useful proportions.

Cells used are of the "p-n" type. The junction is formed on the wafer surface that is exposed to illumination and is composed of "n"-type and "p"-type semiconductor materials.

The "p"-type and "n"-type silicon are separated by a microscopic barrier layer, in which a built-in, permanent electric field exists. Current flow from this field occurs when light is absorbed by a silicon crystal, causing movement and displacement of electrons and holes. Subsequently, a voltage difference is created at the "p-n" junction between the silicon layers of the cell and an electric current is produced.

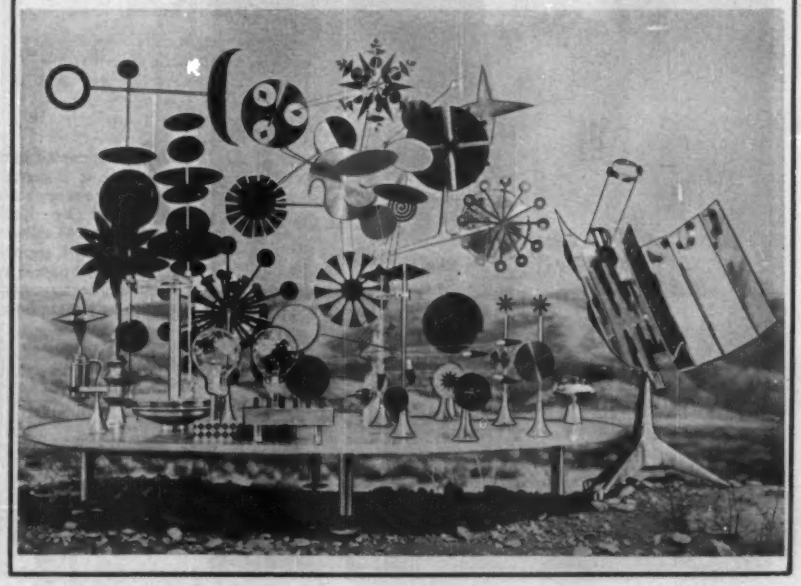
A group of solar cells, arranged in a series-parallel configuration designed to give optimum power transfer to the load, becomes a solar battery. Power generated in excess of operating needs may be fed to storage batteries for use during periods of darkness or overcast skies.

On Eames' Solar Toy, the converted energy drives a group of seven, German-made "Aristo" motors. The tiny, 1½- to 3-volt motors are each connected directly to a drive or crankshaft of the Toy.

The purpose of Alcoa's "Forecast" program, in which Eames' design was the eleventh creation, is to commission great designers to predict problems for tomorrow and solve them now, imaginatively, through great design in aluminum. The program is broadly concerned with design for the home and family. Alcoa has gone wherever the imagination sufficient to do the task exists; to a Paris couturier, a graphic artist, sculptor, painter, and architect.

It is reasonable to assume that the sun, both as an energy source and as an intimate part of man's environment, will be a concern in several future "Forecast" designs. Charles Eames has pointed the way with his ultimately functional, functionless Solar Toy.

(Photo by Aluminum Co. of America.)



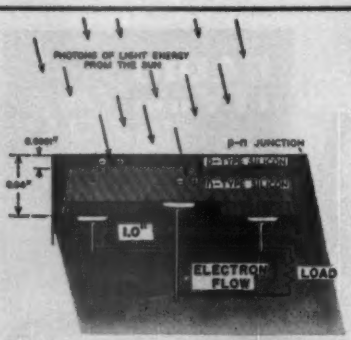
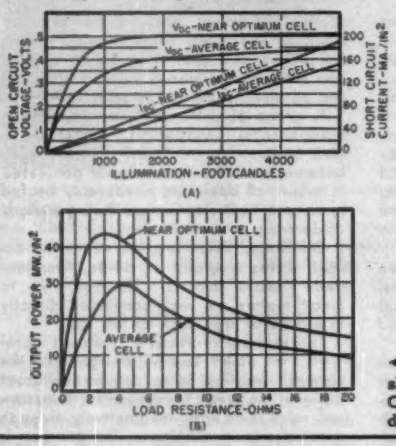


Fig. 2. Cross-sectional view of silicon plate prepared as a solar cell, showing creation of electron-hole pairs by light energy. (Courtesy Bell Telephone Lab.)



← Fig. 3. (A) Open-circuit voltage and short-circuit current vs illumination. (B) Output for various loads, 5000 foot candles. (Courtesy International Rect. Corp.)

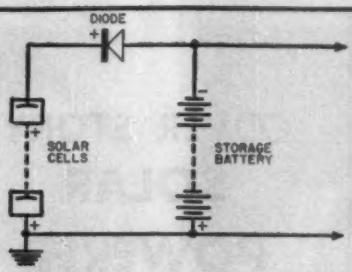
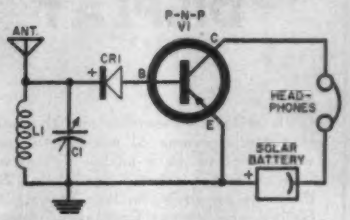


Fig. 4. Typical circuit for a solar battery used to charge some storage batteries.



C_1—365 μμfd. tuning capacitor
CR_1—1N64 germanium diode
L_1—Ferrite-core antenna
Solar Battery—Single-cell silicon battery (International Rectifier Corp.)
Headphones—High-impedance magnetic headphones
V_1—"p-n-p" junction transistor (Radio Receptor RR125, G-E 2N76 or 2N190, RCA 2N77, or equiv.)

Fig. 5. Light-powered radio receiver circuit. (Courtesy International Rect. Corp.)

a storage battery, but this battery would be kept charged by solar batteries. It is interesting to note that silicon solar cells operate effectively under widely varying environmental conditions—from −65° C. to +175° C.

A very novel and interesting application appears in the new "Solaris" hearing aid recently announced by *Zenith Radio Corporation*. Four tiny silicon solar cells are mounted on top of hearing-aid eyeglass frames in which the transistorized amplifier is installed. Sufficient power can be obtained to operate the hearing aid on a bright or slightly overcast day. An auxiliary battery provides the necessary power when the output of the solar battery is too low for proper operation.

A good project for the experimenter is the light-powered radio receiver shown in Fig. 5. With a single silicon solar cell as the only power source, this receiver will bring in local stations at headphone volume even in fairly dim artificial light. With bright light, powerful local stations, and a length of wire added to the ferrite-core type antenna, the receiver will drive a small loudspeaker. In this case a universal output transformer is employed, with the highest impedance primary connected in place of the headphones.

Silicon solar cells are expected to have an extremely long life under normal operating conditions. They are solid-state devices and are essentially rugged. If properly cared for, they certainly should last as long as silicon transistors.

Efficiency

What about possible increases in efficiency? A great deal of research is being devoted to this problem and it appears that further moderate increases may be obtained. Because of the nature of light and the characteristics of silicon, the maximum theoretical efficiency is about 23%.

Losses in the cell include reflection from the surface, recombination of the hole and electron pairs before they can be separated by the field, and ohmic losses in the cell itself. All of these sources of loss are subject to further minimization, resulting in higher efficiencies.

Cost

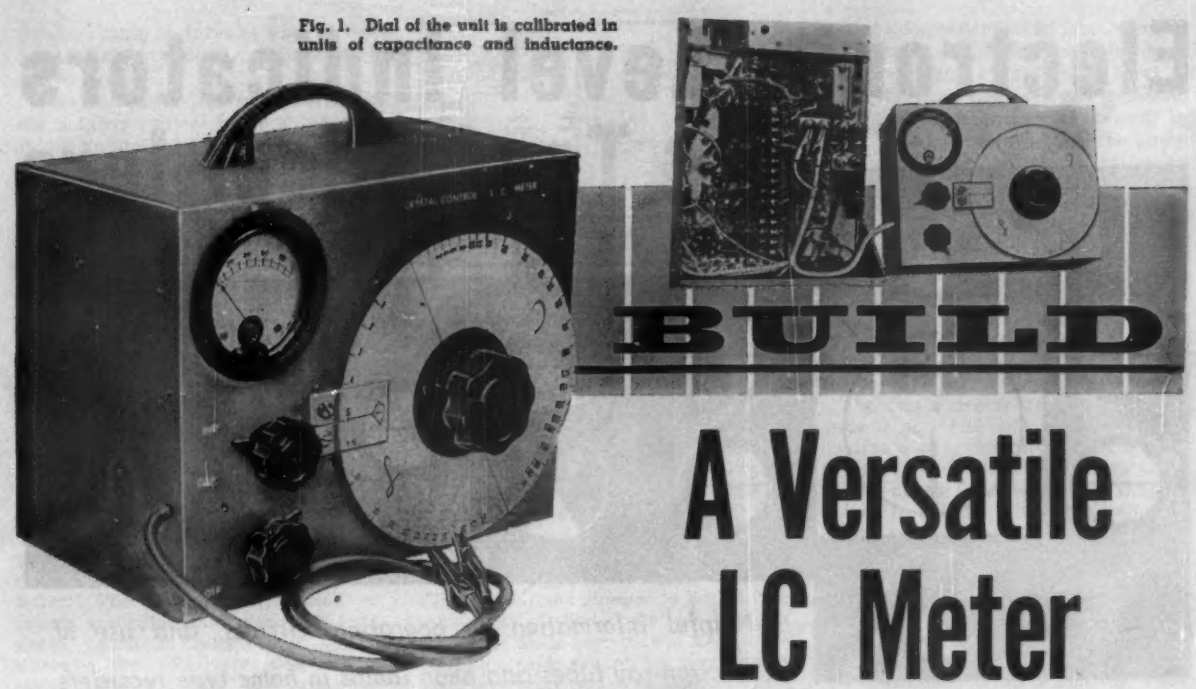
Can the cost of solar cells be decreased? This, again, depends on many factors but it is obvious that with improved technology and higher production, costs should continue to go down. There has been a very sizable decrease since the cells were first introduced on the market a few years back.

Although silicon is one of the most plentiful elements on the face of the earth, it is also one of the most chemically active. Thus, purification poses a real problem and silicon of the proper purity is very expensive. The actual amount of silicon in each cell is rather small, of course, but the many handling and processing operations which are required add to the total cost.

The situation may be likened somewhat to that which exists with transistors. The cost of transistors has decreased steadily as demand has risen and new production techniques developed. The same can be expected of silicon solar cells. In the meantime, they can be classed as extremely interesting experimental devices of considerable practical potential. —30—

Shown connected to a voltmeter is a practical solar energy unit developed by Hoffman. The 144 silicon solar cells will supply five watts of power to a 6-volt battery system in bright sunlight.

Fig. 1. Dial of the unit is calibrated in units of capacitance and inductance.



BUILD

A Versatile LC Meter

By
GENE BRIZENDINE

Wide-range, in-circuit capacitor testing without complications is just one of the jobs it will do.

SMALL capacitors are probably the most elusive of all components when it comes to pinning down their exact capacity. This is largely due to the several marking systems in use and their myriad shapes and sizes. Also, when they are removed for testing and resoldered back into the chassis, the same lead capacitance is seldom in effect. To alleviate this situation, this direct-reading, "in-the-circuit" instrument (Fig. 1) was devised. In use, the leads are clipped across the capacitor, the dial rotated for minimum meter reading, and—presto—the component value is shown directly on the dial. Values from 1 μμfd. to .01 μfd. are easily read. In addition, the instrument can check the value of inductors in the range from 1 microhenry to 200 microhenrys.

Circuit

Basically, the circuit is a crystal-controlled grid-dip meter. The use of a crystal stabilizes operation. Fortunately, it also actually reduces the number of components required. The crystal frequency is not critical, provided it is in the resonance range of the measuring tanks, as described later. The one actually used was a 4.5-mc. unit.

The 3S4 tube (V_1 in Fig. 2) was chosen due to the modest voltage requirements. Also, less heat results from the smaller filament-dropping resistor. Excessive heat could cause drift in readings if a larger tube were used. Use of a.c. and the simple filament resistor eliminates need for the usual power supply and transformer.

The variable measuring tank is coupled to the Pierce crystal oscillator so that a sharp minimum is indicated by the meter when the measuring-tank dial is adjusted to resonate at the crystal frequency. When the instrument is clipped across an unknown capacitor, the dial is rotated to reduce the total tank capacity by the amount of the unknown capacitor. Since the dial is calibrated in capacity, the value of the unknown capacitor can be read directly.

The capacity contributed by the 3-foot test lead is a permanent part of the tank capacity and is automatically compensated for in the calibrating procedure.

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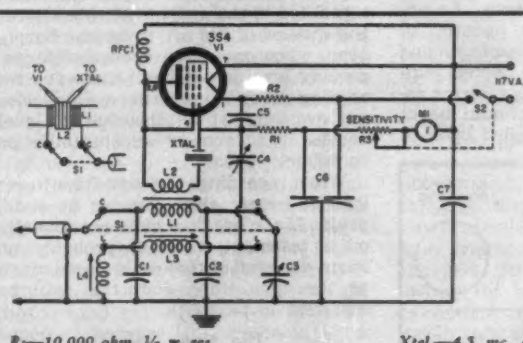
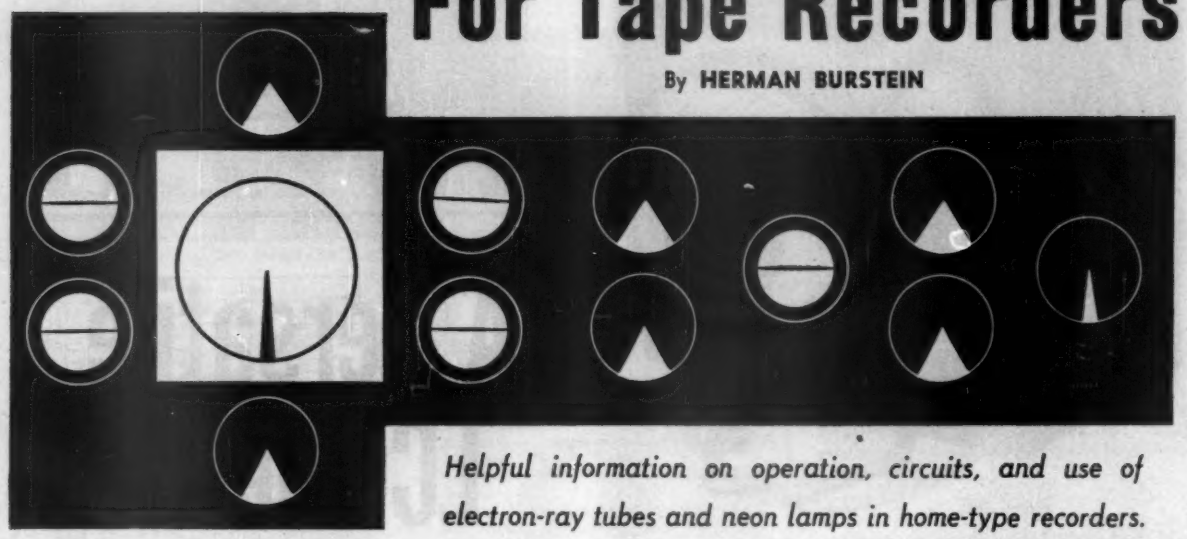


Fig. 2. Schematic of the LC meter. Note the detail to the left when preparing to wind coils L_1 and L_6. This procedure is explained in the text.

R_1—10,000 ohm, ½ w. res.
R_2—750 ohm, 10 w. wirewound res.
R_3—500,000 ohm pot ("Sensitivity")
C_2—60 μμfd. silver mica capacitor
C_3—70 μμfd. silver mica capacitor
C_4—140 μμfd. midget tuning capacitor (Hammarlund MC-140-S, "Meter Tuning")
C_5—2.5-6 μμfd. ceramic trimmer (Centralab 820, "L" range coupling)
C_6—50 μμfd. mica capacitor
C_8—.004/.004 μfd. dual ceramic button capacitor
C_7—.0015 μfd. mica capacitor
M_1—0-1 ma. meter (Weston Model 507 or equiv.)
RFC_1—2.5 mhy. r.f. choke (National R-100 or equiv.)
Xtal.—4.5 mc. crystal, sealed, wired-in leads (Hunt Corp., type not critical)
S_1—D.p.d.t. switch
S_2—S.p.s.t. switch (on R_3)
L_1—35 t. #30 en., closewound on ⅜" slug-tuned form (Bud 69052)*
L_6—5 t. small-gauge, shielded wire with overall insulation, closewound over L_1. Shield connected to pin 7 of V_1.*
L_5—37 t. #30 en. closewound on ⅜" slug-tuned coil form (Bud 69052)
L_4—61 t. #30 en., closewound on ⅜" slug-tuned coil form (Bud 69052)
V_1—3S4 tube
**Connections to L_1 must be made exactly as shown in sketch at upper left of diagram, including L_1 shield, which forms a Faraday shield between L_6 and L_1.*

Electronic Level Indicators For Tape Recorders

By HERMAN BURSTEIN



Helpful information on operation, circuits, and use of electron-ray tubes and neon lamps in home-type recorders.

A TAPE recorder should include an indicator of some sort to inform the user whether he is recording at a proper level or not, since excessive distortion will result from too high a level and an inferior signal-to-noise ratio from too low a level. Although a number of tape machines, particularly professional and semi-professional ones, employ vu and similar meters, electronic indicators are generally used in home-type recorders. This includes a number of tape machines suitable for high-fidelity applications.

Electronic indicators are of two kinds, the electron-ray ("magic eye") tube and the neon glow lamp. An understanding of how they operate, of their circuitry, of their advantages and disadvantages relative to meter indicators, and of the various problems associated with their use should be of value to the technician called upon to repair, adjust, or modify a home tape recorder. It should also be helpful to the audiophile desiring best results from his tape recorder, especially if he is inclined to tinker with the insides of his audio equipment from time to time. Unless the technician or audiophile understands electronic indicator circuitry, it is quite possible that in making a repair, adjustment, or change he may defeat the true purpose of the indicator.

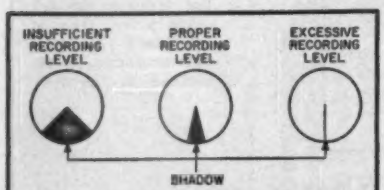
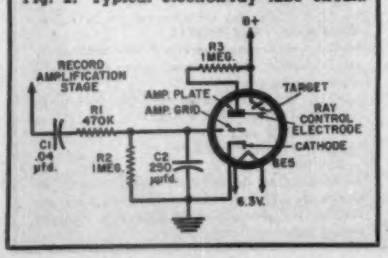


Fig. 1. Action of an electron-ray tube.

Fig. 2. Typical electron-ray tube circuit.



The Electron-Ray Tube

Action of the electron-ray tube—the 6E5 is probably the most popular type—is illustrated in Fig. 1. The audio signal fed to the grid of the tube causes the shadow of the eye to be just barely open when maximum permissible recording level is reached. Excessive recording level causes the eye to close or overlap, while insufficient level causes it to remain substantially or completely open.

When recording, the user tries to set gain to nearly close the eye on audio peaks. If the eye does close occasionally on a transient, there is probably no harm done but if the eye is closed much of the time, tape distortion will be manifest in playback.

The Neon Lamp

The less expensive recorders tend to employ a neon glow lamp, usually an NE-51, as an indicator. At maximum permissible recording level, the audio signal fed to the lamp causes it to fire.

Although a single neon lamp can indicate when recording level is too high, it cannot also indicate whether the level is too low. Therefore frequent practice is to use a second lamp which ignites at a lower recording level. When the latter is ignited, the recordist knows that he is putting enough signal on the tape to produce an adequate signal-to-noise ratio. Thus he tries to set the gain control of the recorder so as to keep the second lamp ignited as long as possible without causing the distortion indicating lamp to fire more than once in a while.

Indicators vs Meters

The electronic indicators in common use are generally not as uniform, reliable, or stable as a good meter, particularly the vu meter, which has been especially designed for audio use. Production tolerances for electron-ray tubes or for neon lamps allow individual units to produce significantly different indications. While one NE-51 may require as much as 65 volts a.c. to fire, another may need only 45 volts. This is a difference of about 3 db and when recording at a high level, a further increase of 3 db can raise distortion substantially. When an electron-ray tube or a neon lamp must be replaced, the new one may have significantly different characteristics than the original one.

The skilled recordist knows that maximum permissible recording level varies according to the audio source, since a given amount of distortion is less offensive for certain sounds than others. A meter enables him to adjust recording level fairly precisely. The electron-ray tube permits considerably less accuracy, while the neon lamp is essentially a "go-no-go" device and does not provide intermediate indications.

Electronic indicators require substantially greater driving voltage than do meters. An electron-ray tube such as the 6E5 requires between −6 and −8 volts to completely close the eye, while

the neon lamp requires at least 65 volts d.c. and, more typically, about 80 volts d.c. to fire.

Bias current fed to the record head has a fairly critical value if one is to obtain an optimum combination of low distortion, good treble response, and high signal-to-noise ratio. Therefore in tape machines employing a vu meter as a record-level indicator it is frequent practice to also use the meter for measuring bias current by means of a switching arrangement. Unfortunately, the electron-ray tube and neon glow lamp do not have sufficiently accurate characteristics to permit their use in this respect.

Advantages of Indicators

Much lower cost is the primary advantage of the electronic indicator. In terms of function, the electronic indicator has an important advantage in that it reads true peak level, without the lag that occurs in the meter because of the mechanical nature of the latter. The electronic indicator responds immediately to the rapid transients found in music and speech, whereas the relatively slow-moving meter only partially indicates true level. To minimize distortion and maximize signal-to-noise ratio, it is highly desirable to know the actual peak recording level. In the case of the meter, an allowance has to be made for the difference between the meter reading and the actual level on transients. Depending upon the program metered, peaks may be from 5 to 20 db above the meter reading, so that considerable experience is required to accurately judge the true peak level.

Electron-Ray Circuits

A typical magic-eye circuit, employing a 6E5, is shown in Fig. 2. The ray control electrode partially deflects the electron stream flowing from cathode to target, thereby forming a shadow in the circular fluorescent pattern caused by this stream. When the amplifier grid goes negative and the amplifier plate therefore goes positive, the control electrode, connected to the plate, also goes positive, and its ability to deflect (repel) the cathode-target electron stream is decreased, thus the shadow decreases, that is, the eye closes.

The 6E5 grid is driven by an audio voltage from a stage of the recording amplifier. To provide the correct amount of signal to the grid, so that virtually full closure of the eye corresponds to maximum permissible distortion, a voltage divider is employed. This consists of R_1 and R_2 in Fig. 2.

A circuit such as Fig. 2 allows the electron-ray tube to flicker rapidly as it follows the changes in audio signal and is, therefore, difficult to gauge the maximum eye indication. To correct this condition a "floating action" circuit, like that shown in Fig. 3, is often used, maintaining the eye for a short while at the maximum position reached.

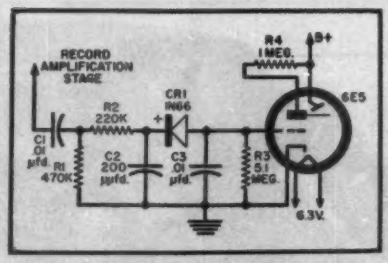


Fig. 3. Typical electron-ray tube circuit uses "floating action." See text.

The values of R_3 and C_3 are chosen so that C_3 is substantially charged by the negative portion of the audio signal in about .001 second through the 1N66 diode. The very high back resistance of the diode requires that C_3 discharge essentially through R_3. The high value of R_3 results in a discharge time of about .05 second for C_3, so that the magic eye reading is maintained long enough to be readily noted.

If it becomes necessary to replace CR_1 in a circuit similar to Fig. 3, the same type of diode must be used. If a popular diode such as the 1N34 were used as a replacement, its much lower back resistance would impair the performance of the circuit. Instead of a crystal diode, some tape recorders employ the spare half of a dual triode—with plate and grid tied to form a diode—in order to achieve the required high back resistance.

Neon Lamp Circuit

Fig. 4 shows the neon lamp in a typical record-level indicator circuit. In some tape machines enough audio voltage is available to fire the lamp. About 65 volts a.c. or 90 volts d.c. is the maximum required to fire the lamp, although appreciably less is often sufficient. Audio voltages of this magnitude are sometimes present as the result of using a high inductance head in the recorder. This, in turn, requires a large constant-current resistor in series with the head (to prevent the head's inductance from discriminating against treble frequencies). Because of the high circuit impedance, a large voltage—65 volts a.c. or more—may be necessary to drive sufficient current through the head to obtain the desired recording level on the tape. By employing a power tube such as a 6AQ5, 6V6, EL84, etc., voltages of the required magnitude can be obtained. The power tube that is used ordinarily serves a double purpose, because in playback it is switched into service as an output tube that is employed to drive the self-contained speaker in the tape recorder.

In many tape machines, however, audio voltages of sufficient level to drive the neon lamp are not available. Therefore the neon lamp is "biased" by a d.c. voltage obtained from the power supply. In this case the audio signal has to supply only the difference between the biasing voltage and the voltage needed to fire the lamp. In Fig. 4, a voltage divider network comprising R_2 and R_3 produces a 58-volt d.c. bias voltage. The audio voltage is in series with the 58 volts d.c. Positive halves of the audio signal raise the total voltage to the magnitude necessary to ignite the lamp.

Fig. 5 is a circuit where a "normal" lamp is added to indicate whether recording is at sufficiently high level. The "normal" lamp fires at a lower audio signal, about 6 db less, than that required to fire the "distort" lamp. The latter requires a higher voltage because of the voltage divider action of R_2 and R_3. Instead of a d.c. biasing voltage, the supersonic bias current is employed here to help fire the lamps; C_2 and C_3 adjust the bias current to the proper level.

The neon lamp has a built-in "floating action" inasmuch as the extinction voltage is appreciably less than the firing voltage. For example, if 90 volts d.c. is necessary to fire the NE-51, the lamp will stay on until the voltage drops to about 50 volts d.c.

Loading Distortion

Irrespective of the type of record-level indicator used, meter or electronic, precautions must be taken so that the indicator will not seriously load down the audio signal and thereby cause significant distortion. This requires that the impedance of the indicator circuit be considerably greater—at least 10 times—than that of the audio circuit impedance. If one is tempted to make changes in a record-level indicator circuit, one must be careful not to substantially reduce the load impedance presented by the indicator.

In a typical electron-ray circuit such as the one shown in Fig. 2, application of the positive portion of the audio signal to the grid causes electron flow from cathode to grid; since the cathode is at ground, no negative bias exists on the grid. In effect, on positive signal swings the load (the magic-eye tube) presents a small resistance to the signal in view of the current flowing from cathode to grid. On negative signal

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Fig. 4. Typical neon glow lamp circuit.

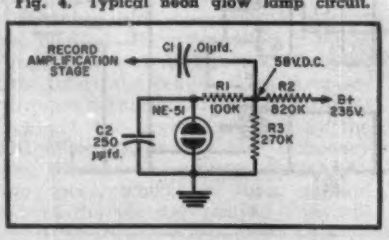
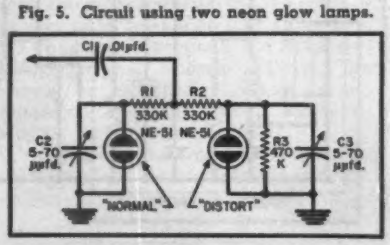


Fig. 5. Circuit using two neon glow lamps.



Telephone of the Future

Here is the push-button phone described.

Push-buttons take the place of the dial and transistor "sound radiator" takes the place of a bell in this unit.

By **HAROLD McKAY**

THE dial system which has served the nation's telephone needs for the past 50 or more years is built around circuits which use electromagnetic relays and multiple-position switches. These operate either by electromagnetic ratchets or electric motors. While the telephone companies pioneered the use of the vacuum tube in amplifiers, electronics has been slow to come to the switching branch of the business.

One of the difficulties in adapting any new idea to the telephone system is that it must be made to work with the older equipment already installed. The rapid advances in the computer field have resulted in electronic switching techniques which would readily work in a telephone system, if such a system could be made all electronic.

For example, a subsidiary of the *International Telephone and Telegraph Corporation* developed a shipboard electronic telephone system for the French Navy. Another all-electronic telephone system was developed for the United States Navy by *Stromberg-Carlson Company*. At a recent telephone convention electronic switching systems were exhibited by *Automatic Electric Company* and *Stromberg-Carlson*. Both of these systems used regular telephone instruments equipped with dials, but the dial pulses instead of actuating ratchet switches were counted by semiconductor devices and vacuum tubes.

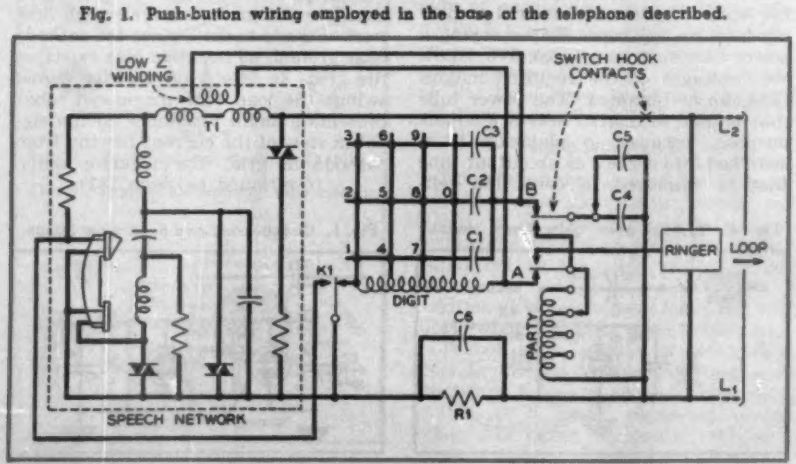
A good part of the long-distance calling in the United States today is not done by dial pulses but by tones of different frequencies. One reason for this is that dial pulses of ordinary telephones consist of interrupted direct current, which is fine for relays and switches, but will not go through amplifiers and carrier systems.

In a central office when an operator calls a long-distance number, she uses a small keyset like that on an adding machine, which sends tones in the audio range over the long-distance circuit. If the customer dials the number, the direct current pulses from his dial are converted by relays into spurts of tone of different frequencies.

Engineers dream of applying the multi-frequency principle to ordinary telephones, but the system used by the operator is out of the question because it involves separate vacuum-tube oscillators for each of the several frequencies. Another consideration is that if a set of push-buttons is to take the place of a dial on a telephone a means must be found whereby these buttons will operate the relays in an old-fashioned direct-current office.

An experimental instrument has been developed by the *Bell Telephone Laboratories* which might well be a prototype for the telephone of the future. It consists of an ordinary handset with a set of ten push-buttons in place of a dial. Beneath the push-buttons is a cross-wire network which is connected to a tapped inductance on one side and a set of three capacitors on the other. The wiring is so arranged that pushing any button causes a connection to be established between one of the taps on the coil

Fig. 1. Push-button wiring employed in the base of the telephone described.



and one of the capacitors. This numbered network is shown in the center of Fig. 1.

In operation, when the receiver is removed from the switch hook, direct current will flow in on L_1 through the coil marked "Party," through contact A, through the coil marked "Digit," through the contact K_1, the telephone transmitter, transformer T_1, and out to the line at L_2. This will cause the two coils to be electromagnetically charged. When any one of the numbered buttons is pressed, one of the three capacitors will be connected across a portion of the coil. This will establish a series-resonant circuit for a definite frequency which lies somewhere in the range of 1111 to 2868 cycles. As the push-button is pushed all the way down, switch K_1 operates. This switch has a "Micro-switch" type of action so that it snaps over after the cross-point connections have been made.

The operation of K_1 opens the circuit by which the direct current was flowing through the two coils. This causes the digit coil to react with one of the capacitors to produce a short wavetrain of a definite frequency. This spurt of tone is induced from the low-Z winding of T_1 onto the telephone line where it is transmitted to the office.

A difficulty which might occur with this type of system is known as "talk-off." This is the condition which would arise if voices or other sounds which might be picked up by the telephone transmitter contain frequency components the same as one of the digits. If these were received by the central office, it could result in wrong numbers. In order to prevent this, the central office circuit has an enabling device which will recognize frequencies only during the instant that the telephone button is pushed. Switch K_1 does this. At the moment it cuts out the coil it cuts in resistor R_1. This instantly lowers the direct current flow in the line which causes a gate circuit in the office to open to receive the tone. At the same time switch K_1 also short circuits the telephone transmitter so that voices or other sounds will not interfere with the tone as it is being transmitted.

On party telephone lines it is necessary, for billing purposes, to know which of the parties originates a call. This would be accomplished in the proposed telephone by means of the coil marked "Party" and capacitors C_4 and C_5. By changing the connections on the coils and capacitors any one of eight different resonant-frequency circuits can be set up. These frequencies would lie in the range of 478 to 1000 cycles-per-second, so as not to interfere with the digit frequencies.

When switch K_1 operates as a button is pushed down, the "Party" coil and capacitors also send a spurt of tone which will identify the party making the call. This identification will be made each time a button is pressed. The unlabeled components

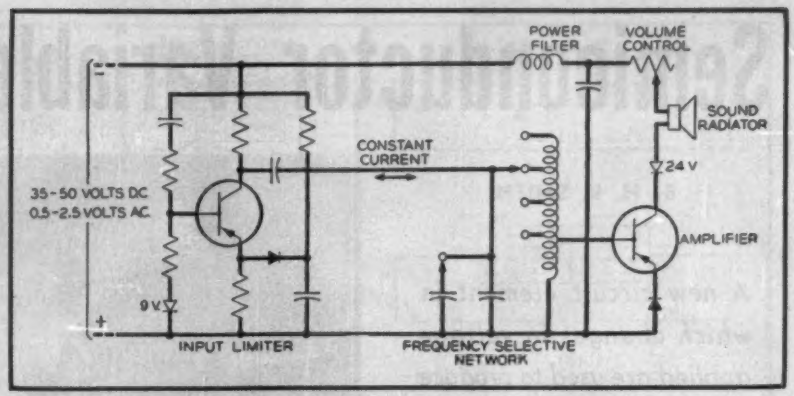


Fig. 2. Instead of a mechanically operated bell, this circuit is employed.

in the speech network perform various functions, such as keeping direct current from demagnetizing the receiver, preventing excessive feedback or "side tone" from the transmitter feeding into the receiver, and current limiting by means of varistors.

If a telephone of this sort were to be connected to an electronic central office, its various frequencies might be received by different tuned circuits or frequency-responsive relays much in the fashion of the devices used in mobile radio. However, present-day mechanical dial switching offices have devices which count dial pulses and "register" the number dialed upon a set of relays. Rather than use ten-digit relays on each position of the register, equipment is conserved by using only five. In some systems these might be numbered 0, 1, 2, 4, and 7. The missing numbers are made up by a combination of two of the foregoing digits. For instance, if the customer dials a 3, relays 1 and 2 are actuated; if he dials 6, relays 2 and 4 operate.

In order to co-ordinate this type of system with a multi-frequency push-button telephone, a special circuit could be used. Here the line connects to the push-button telephone. An enabling circuit, a transistor-fed relay, responds to the drop in current when switch K_1 in the telephone operates. Its operation supplies plate voltage to thyratron tubes and register relays for each digit.

A cut-a-part filter separates the digit frequency and the party frequency, although each is handled in a similar manner after being separated. The transistor amplifier connects with a set of selective circuits, each of which is tuned to a different one of the frequencies which can be received. These are shunt-resonant circuits so each will pass a single frequency.

When a given frequency is passed by one of these circuits it goes through crystal diodes to two thyratron tubes and relays. This is in accordance with the "2 out of 5" requirement of the register circuit in the dial office. Thus any one frequency goes through two crystal diodes into two tubes, which, in turn, operate two of the register relays. This will satisfy the requirements of the electro-mechanical equipment in the dial central office, which will take over and handle the call from that point. The use of the crystal diodes in the translator prevents the current from the wire of one frequency backing up onto one of the others.

A telephone to be completely electronic could not use a telephone bell as we know it today. One reason for this is that present telephone bells are inefficient by electronic standards. It takes about 1 watt of power to energize the armature and the clapper which strikes the bell. On the other hand, good speech can be reproduced over a telephone with as little as 1 milliwatt of power. Thus it would be one thing to build an electronic system which would handle 1/1000 of a watt in order to provide voice transmission and switching, but quite a different order of magnitude to provide a system which would also supply 1000 times this amount of power to ring the bell.

Again, any approach to altering this situation should recognize that the new system must be compatible with the old.

An answer seems to be a "sound radiator," a small loudspeaker which can be concealed inside the base of the telephone and which will emit a pleasing tone when the customer is called. A device for use with present-day telephones consists of a transistor oscillator in which the winding of the speaker forms part of the tuned circuit. On present-day telephone lines, which use 105 volt, 20-cycle a.c. to ring the bell, a diode rectifier would convert this to d.c. to operate the oscillator and cause the speaker to sound. An all-electronic system could use a circuit such as that shown in Fig. 2.

Here the 35 to 50 volts direct current shown represents the d.c. that is always on a telephone line. The .5 to 2.5 volts a.c. represents the voice-frequency signal voltage. These are shown as variables, because actual telephone lines may be of different lengths or characteristics.

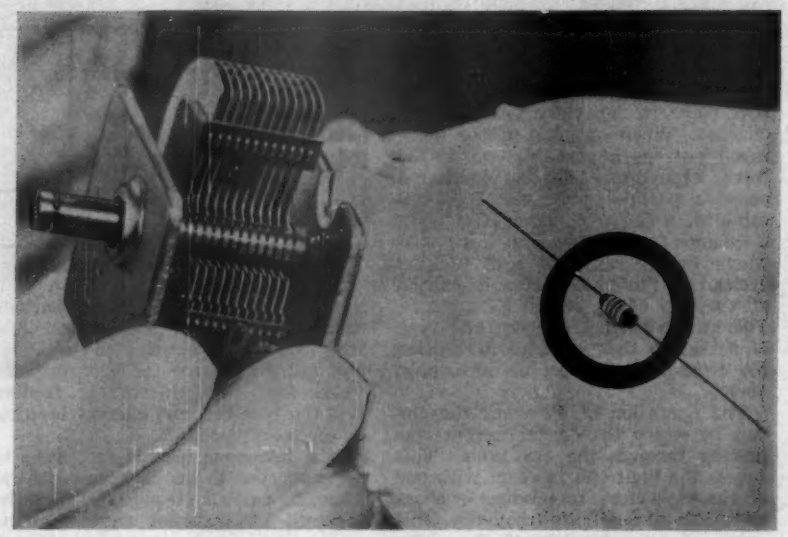
The input stage of Fig. 2 consists of a transistor-limiter circuit, the a.c. output of which is a symmetrically

(*Continued on page* 107)

Semiconductor Variable Capacitors

By **H. R. SMITH**

A new circuit element in which changes in voltage applied are used to produce changes in capacitance.



"Varicap" is compared with ordinary tuning capacitor.

Engineers are examining a gold-bonded diode modulator similar to that employed in a new microwave radio relay system.

DID YOU ever think of a germanium or silicon diode as a variable capacitor? Probably not—but it can be and a good one at that! In a properly constructed diode, the capacitance can be varied over fairly wide limits by merely varying the voltage across it.

To understand how this can be, let's briefly examine the basic structure of a typical junction diode. This structure is indicated in Fig. 1, where you can see that it consists essentially of a junction between *p*-type and *n*-type silicon or germanium.

We should perhaps pause here a moment to discuss what is meant by *p*-type and *n*-type material. Absolutely pure semiconductor material is completely neutral, that is, it has neither an excess nor a deficiency of electrons in its crystalline structure. However, if we add a very minute amount of an impurity, such as arsenic, we can introduce an excess of electrons, leading to *n*-type material. By introducing a different impurity, such as gallium, we can rob the material of some electrons, leaving positively charged "holes," a characteristic of the *p*-type material.

Now that we have *n*-type and *p*-type material, we form our *p-n* junction by placing these two materials next to each other. This can be done in several different ways. A technique developed at *Bell Telephone Laboratories*, called diffusion, is an excellent way of doing it. We start with *n*-type material and diffuse into it a small amount of *p*-type impurity thus forming the desired *p-n* junction.

Here we have the basic elements of a capacitor—two conductors (the *p*-type and *n*-type material) separated by an insulator. The neutral layer between the *p*-type and *n*-type material serves as the insulator. Thus we have a diode capacitor.

Now let's see what happens if we apply a voltage to this diode. We can see immediately that the effects of this voltage will depend on its polarity, so let's first connect the positive terminal to the *p*-type material and the negative terminal to the *n*-type. The electrons in the *n*-region will be repelled over into the *p*-region and the positive holes will tend to move from the *p*-region to the *n*-region. Thus we have all the conditions for a flow of current and this is exactly what takes place. We say that the diode is "forward-biased" and will pass current.

If we reverse the voltage on the diode, the positive voltage tends to attract the electrons in the *n*-region, keeping them from moving over into the *p*-region. Also, the negative voltage attracts the positive holes, preventing them from moving across into the *n*-region. Therefore we will have no flow of current. Furthermore, the applied voltage will produce a region between the two layers where no charge exists and the higher the voltage the thicker this no-charge region. We call this the "reverse-bias" condition for the diode. This is shown schematically in Figs. 2B and 2C.

We know that the actual capacitance of a capacitor depends inversely on the thickness of the dielectric between the two conducting plates, all other things being equal; that is, the thicker the dielectric, the less the capacity. Thus, we have here in our reverse-biased diode all of the conditions for a variable capacitor. At zero bias, we have minimum thickness of the center layer and thus maximum capacity. As the reverse bias is increased, the thickness of this center layer increases and the capacity decreases up to the point where the reverse voltage is sufficient to cause breakdown.

This explanation is perhaps somewhat oversimplified and ignores many factors which should be taken into consideration; however, it does give a reasonably accurate picture of the conditions in a reverse-biased diode capacitor.

Semiconductor capacitors are available from at least two companies. *Pacific Semiconductors, Inc.* uses the tradename "Varicap" for its alloy junction silicon units while *International Rectifier Corp.* has selected the tradename "Semicap." If you are interested in experimenting with this new component, representative units are available on the open market.

With a new component of this nature, a problem arises as to the best means of indicating it on a schematic diagram. *Pacific Semiconductors* has selected the representation shown in Fig. 3. It is a composite representation and includes the two plates for a capacitor, an arrow to indicate variability, and the conventional diode symbol

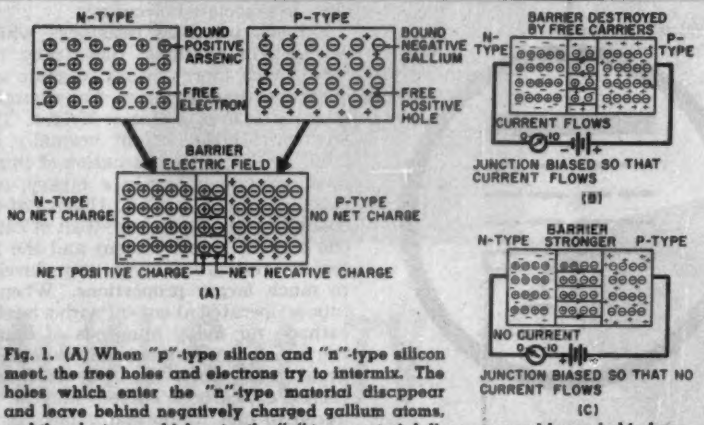


Fig. 1. (A) When "p"-type silicon and "n"-type silicon meet, the free holes and electrons try to intermix. The holes which enter the "n"-type material disappear and leave behind negatively charged gallium atoms, and the electrons which enter the "p"-type material disappear and leave behind positively charged arsenic atoms. These fixed charges constitute an electrical barrier which prevents the rest of the holes in the "p"-side and electrons in the "n"-side from intermixing. (B) This barrier is responsible for the rectifying properties of "p-n" junctions. If a voltage is applied across the junction in a way such that the natural barrier field is overcome by the applied voltage, then holes are encouraged to flow into the "n"-side, and electrons are encouraged to flow into the "p" side. (C) If a voltage is applied across the junction in a way such that the natural barrier field is re-inforced, the holes are more firmly captured in the "p"-side and the electrons in the "n"-side. No free charge can cross the barrier; therefore, no current will flow. Courtesy of the Bell Telephone Laboratories.

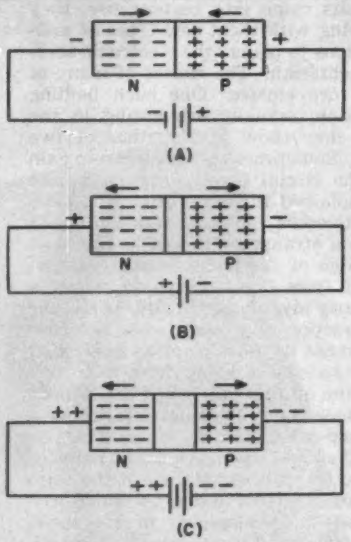


Fig. 2. Situation existing in a diode under various bias conditions. (A) Forward bias, (B) small reverse bias, and (C) large reverse bias conditions are illustrated.

in the background. We will stick to this representation in the diagrams presented here.

What sort of capacitance and *"Q"* (figure of merit) values are available with this new component? Fig. 4 shows the variation of capacity *vs* voltage for a typical "Semicap." As can be seen, the capacity ranges from about 38 μμfd. down to 3 μμfd., a very useful variation for many applications. The *"Q,"* as indicated in Fig. 5, is well over 1000 at one megacycle, which is as good as that of many fixed capacitors. The *"Q"* decreases with frequency, as can be expected, but the units may be used up to 500 mc. in applications where high *"Q"* is not required. The *"Q"* can be effectively increased by placing a high-quality fixed capacitor in series with the diode.

"Varicaps" are available with capacitance values of 20 to 56 μμfd. at −4 volts bias. Total variation available is better than 4-to-1 within the voltage ratings. Maximum permissible voltage on most units is around −20 volts.

Continued efforts are being made to increase the *"Q"* by decreasing the effective series resistance. For example, scientists at *Bell Telephone Laboratories* are working on an experimental diffused-base silicon diode which is useful at frequencies well up into the thousands of megacycles. This unit has an active diameter of about .002 inch and incorporates a special construction to minimize inductance and capacitance of the attached contacts. Series resistance is extremely low, with the result that *"Q"* is high.

Now that we have this variable capacitor, what is it good for? *Pacific Semiconductors* lists sixteen potential applications and implies that others will undoubtedly come to mind as engineers and scientists continue their exploratory work.

Probably the most logical application is that of voltage tuning, as shown in Fig. 6. Here the capacitor is a part of the tuned circuit and is isolated from it for d.c. purposes by a large blocking capacitor. Z is a choke to prevent r.f. from feeding back into the bias source. Tuning is accomplished by varying the potentiometer setting, thus varying the voltage across the diode capacitor. If this voltage were derived from a suitable control circuit, such an arrangement could be used for automatic frequency control in AM or FM receivers.

If the d.c. control voltage is replaced by an a.c. source, we have a ready means of obtaining frequency modulation. A circuit proposed by *Pacific Semiconductors* for this purpose is shown in Fig. 7. Such an arrangement

(*Continued on page* 122)

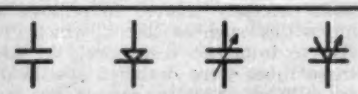


Fig. 3. Development of "Varicap" symbol.

Fig. 4. Capacity vs bias for "Semicap." Courtesy of International Rect. Corp.

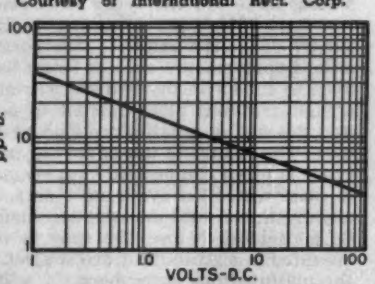
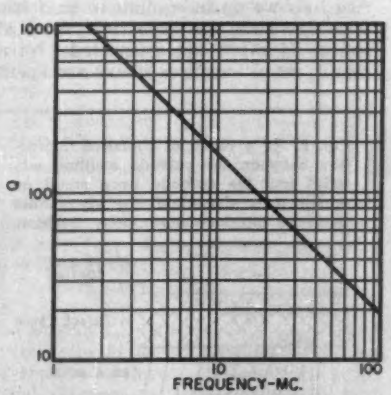


Fig. 5. "Semicap" "Q" versus frequency. Courtesy of International Rect. Corp.



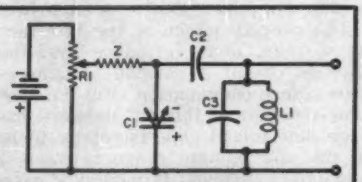
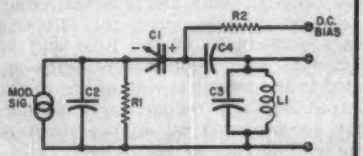


Fig. 6. Voltage tuning by means of a variable capacitor unit. Refer to text. Courtesy of Pacific Semiconductors, Inc.

Fig. 7. Circuit for providing FM signal. Courtesy of Pacific Semiconductors, Inc.



Lazy Tube Cathodes

By CHARLES T. McCORMACK
and
CLEMENT D. MACKEY

Many puzzling types of circuit malfunction are caused by a subtle change inside the tube itself.

AS NEWER and more complex circuits come into regular use, they bring with them new types of malfunctions to plague the electronic service technician. The causes of many of these are elusive. One such baffling condition, actually originating in the tube, may show up in either of two ways. Sometimes there is a loss in gain for the circuit involved which cannot be explained in terms of conventional defectiveness. At other times, it shows up as a strange overshoot at the leading edge of the pulse or other output signal from a stage, whose origin is similarly mystifying. In either case, the malfunction may persist even after replacement of tubes or other parts that are suspected of being defective.

A film of material, called the cathode interface layer, often develops in many vacuum-tube cathode structures. As Fig. 2 shows, this layer forms between the active emitting surface of the cathode and the base metal on which it is deposited. Development of the interface compound is the result of chemical interaction between the emitting material itself and the base metal or some constituent of the base metal.

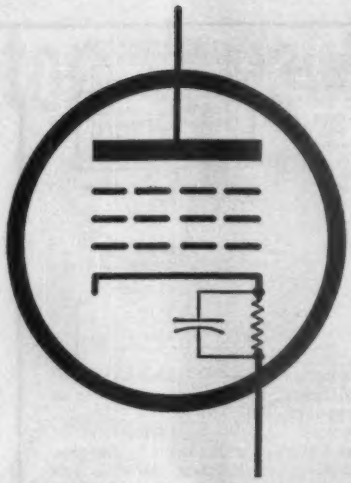


Fig. 1. The interface layer has some resistance. Also, it acts as a dielectric between the emitting coating and the base metal. Thus it helps to form a capacitor that is in parallel with its own resistance—an RC network.

Once formed, the interface layer may exhibit several interesting properties.

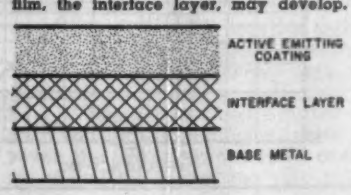
For one thing, the compound may act as a semiconductor. The resistance of the layer may range from a few ohms to several hundred ohms. Unexpected circuit elements of this nature can obviously have appreciable influence on the tube's operation. Nor is this all. Once the interface layer is present, it can act as a dielectric, although a rather leaky one, between the emitting coating and the base metal. The two last-mentioned elements then become the electrodes of a capacitor.

The over-all effect of the interface layer, then, is to introduce into the cathode circuit a parallel resistance-capacitance combination (Fig. 1). The time-constant of this *RC* network has been determined experimentally to lie in the approximate range between .2 and 2 microseconds. In individual cases it can be much longer.

In video amplifiers, the effect of cathode interface resistance may well be serious. For a signal whose duration is very long as compared to the interface time-constant, the principal effect is a loss in gain, since the effective transconductance of the tube will be reduced. An abrupt discontinuity applied to the tube grid will appear at the output similarly reduced in amplitude, but accompanied by an overshoot at the leading edge of the pulse.

The symptom in the "diseased" cathode, often characteristic of video amplifier tubes, carries the popular designation "slump." The term is applied to a tube which behaves as though there were present in the cathode circuit a parallel resistance-capacitance combination with a time-constant up to several seconds. The response of such a tube to an input negative step or pulse of long duration is an output positive step which gradually slumps to a lower voltage level. The origin of the slump is not well understood. The effect is often a source of difficulty in the design of d.c. amplifiers for cathode-ray oscilloscopes. When the "disease" shows up in equipment that has been operating for some time, the real source is often not suspected. As a result, many needless hours are spent trying to correct faults believed to exist in associated circuitry.

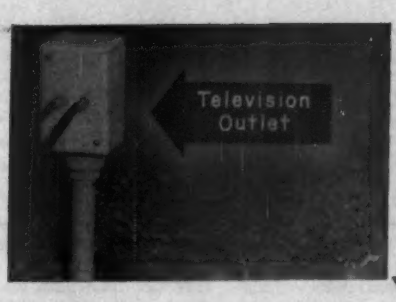
Fig. 2. As a result of chemical interaction between the cathode emitting material and the cathode base metal on which it is deposited, an intervening film, the interface layer, may develop.



Cathode interface resistance which develops in amplifier tubes may become much more serious in some applications than in others. For example, take the case of a binary divider. The flow of cathode current normally inhibits or deters the formation of interface resistance; but in a binary, one tube is normally cut off. Under cut-off conditions, the deterring effect of cathode current is not present and the interface resistance layer may develop to much larger proportions. When a tube is operated at cut-off with a heated cathode for many hundreds of hours, the interface resistance may become so great that, when the tube is finally turned on, cathode current may be reduced to half its normal value. Hence when a binary has remained in one state for a long interval of time, it may well be impossible to induce a permanent transition. This particular condition or "disease" of the tube has been dubbed "sleeping sickness."

Interface resistance is present, to some extent, in all tubes with oxide-coated cathodes but is especially pronounced in tubes whose cathode base material contains large amounts of silicon. It increases with the length of time the cathode is heated. It increases more in tubes operated at cut-off than in tubes drawing continuous plate current. It may appear in new tubes that have had prolonged shelf life. The end of the useful life of a tube may be the result of interface resistance rather than loss in cathode emission.

In recent years a series of special dual-triode vacuum tubes has been developed. The cathodes of these have been carefully treated to remove all impurities, such as silicon, which give rise to interface resistance. At first these tubes were designed specifically for military computer service, but they are available on the open market and are particularly useful in many video, pulse, and digital circuits. Notable among these are the types 5963, 5965, and 5844. The 5963 is similar to the 12AU7. The 5965 and 5844 incorporate other improvements, such as better balance to cut-off in the two sections and a high zero-bias plate current to permit the use of small plate-load resistors. The change to use of special tube types is often the best-advised remedy in cases where the symptom recurs. In any event, careful tube selection should be considered before the tube is exonerated in circuits that are subject to the malfunctions noted here. —30—



An outdoor tap in a buried-cable system, often used in motel jobs.

Multi-Set TV Installations—Problems & Principles

By JACK BEEVER
Jerrold Electronics Corp.

Installing an indoor, non-matching tap-off in the dead space above a ceiling.

Part 2. System layout methods, including an actual case. Common troubles and system troubleshooting.

UP TO THIS POINT we have already given thought to the major components in a signal distribution system. This includes the various cables used, preamplifiers and distribution amplifiers, line splitters, and tap-off units.

We have also discussed signal level in the system in a general way, including losses and the general methods for providing needed gain.

This has been on a more or less abstract level. Photos on this page and the one following will give the reader an idea of what some elements in the chain look like. Actually working out an installation problem, albeit on paper, should further enhance a practical understanding.

System Layout Methods

By this time, the layout of a system should have resolved itself to a fairly simple problem; but two general methods of attack are used. The first and simplest is called the *break-even* system; the other uses a fixed reference level which is usually the level required at a set in a normal installation, generally 1000 μv. per channel. This level of 1000 μv. has become a standard reference level and is used as the "zero db" figure in systems. Manufacturers use varying terminology; *Jerrold's* being dbj, the *j* indicating that 0 db = 1000 μv. Others use the somewhat clumsier but more descriptive db/mv. (decibels over a millivolt).

EDITOR'S NOTE: A fistful of theory is necessary with something new. We had that in Part 1. Here theory is applied to an actual multi-set installation.

The break-even system is based upon calling the antenna signals zero db. In the case of varied levels of signals, the system should be computed on the basis of the lowest level. Unless there is a great discrepancy in levels (30 to 40 db) the larger signals will take care of themselves, since TV sets can handle signal variations up to 40 db (100x). The best method of presentation is to lay out a hypothetical job which can be, for purposes of illustration, a 20-unit motel. Fig. 13 is a sketch of the floor plan.

In this establishment, the office is in the center, with 10 units on each side. The antenna, on a 40-foot mast, is behind the office. It is obvious that we have a layout resembling an inverted *T*, in terms of the cable run. It will require that we split the cable once, in the office. In order to determine what gain will be required to operate this system and what value of isolation will be required at tap-off units, we must know the over-all loss in the system. To determine the loss, we can lay out a schematic of all loss-producing components in the system, ignoring the gain until we know how much gain is required to overcome the loss.

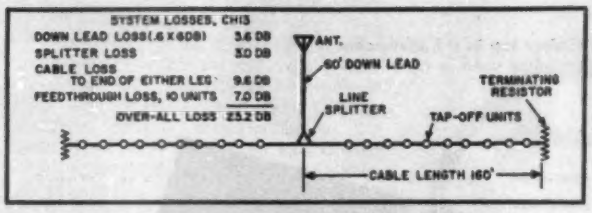


Fig. 11. Diagram of losses for the layout of Fig. 13.

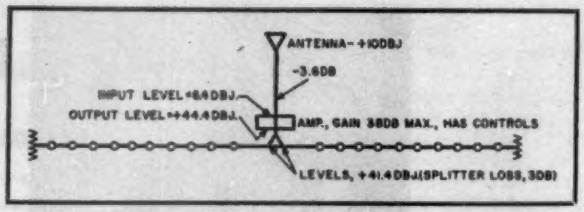


Fig. 12. Signal levels throughout final installation.

Loss-producing components are cable, splitters, and tap-off units. The schematic of Fig. 11 shows these units inserted into the *T* wiring. The downlead wiring should run to about 60 feet and we can take as a first approximation the RG-59/U size cable. This represents a loss of 0.6 (6/10 of a hundred feet) times 6 db (loss of a hundred feet at channel 13), equaling 3.6 db. The line splitter has a 3 db loss per leg. Since both legs of this system are the same, if we calculate one leg, the other need not be figured. It will behave in the same manner. (If we had an asymmetrical system, we would calculate the longer leg, then the shorter one.)

One wing of the motel in Fig. 13 is 130 feet long. However, we are not interested in the building's length, but the cable's length. Inspection of the premises indicates that the wiring from tap-off unit to tap-off unit of adjacent rooms will require 16 feet of cable, making the run along one wing 160 feet, or 1.6 hundreds of feet. The total cable loss will be 1.6×6 db $= 9.6$ db. We still have the feedthrough losses of the tap-off units to contend with; and we cannot at present determine the amount of isolation required which will, in turn, determine the feedthrough loss. We can, however, assume an average. It has been found that a tentative figure of 0.7 db average per tap-off will be reasonable. Ten units, then, will add 7 db to our total, although we are cheating a bit, since the last one doesn't feed through to anything, and doesn't need to be counted.

The addition on Fig. 11 shows a total system loss of 23.2 db to the end of either leg. Isolation between set and system on these "close-coupled" systems should not be less than 10 db per set, allowing the sets to be isolated from each other by a total of 20 db (10 db from any set to system and 10 db from system to adjacent set). This brings our total loss between antenna and the farthest set on the system to 23.2 db plus 10 db or 33.2 db. We need at least this much gain in our system if we are going to arrive at the last set of the system with zero db, which is the antenna signal.

The above calculation, though, allows us no leeway. It assumes that, if we have this gain, we will retain this gain. Unfortunately, amplifiers use tubes and tubes age. A system should operate with at least 6 db excess gain, bringing our gain figures up to 39.2—practically 40 db. If we know that these sets are to operate in an area of high ambient noise, perhaps caused by neon tubes or fluorescent lights, then we may decide to add another 6 db to provide a good signal-to-noise ratio at the set, making our required gain 46 db.

The break-even system tacitly assumes that the antennas do not develop more signal than is needed. However, if this is not true, we can eliminate some of the required gain by considering surplus antenna signal as "gain." In doing this, we have changed from the break-even system to the "dbj" system. This can best be demonstrated by an example.

Assume that at the particular location we are describing the antennas develop 4000 μv. at channel 2, 3000 at channel 5, and 3000 at channel 13. Since these are all similar in signal strength and our losses are greatest at channel 13, the highest frequency channel, the channel-13 signal can be the critical one. We have already indicated that a 1000-μv. signal is our basic unit. Our air signal is about three times as much. The db chart indicates that a ratio of three times is very nearly 10 db. Then we can use this as a gain figure, assigned to the antenna, which now delivers a signal of +10 dbj instead of zero db. The gain we required, 46 db, can be reduced by this amount, leaving 36 db necessary.

We can add the new information to our schematic (Fig. 11) as soon as we decide on what amplifiers are needed. This information can be found from a perusal of manufacturers' catalogues. We decide on a mast-mounted preamplifier, since the place to be serviced is polluted with neon lights. This preamp location will let us bring a high-level signal down into the noisy area and will keep it protected in coax. The one we choose has a 25 db gain.

The same maker lists a small distribution amplifier with the same gain, 25 db, giving us a total of 50 db gain. (We had decided we only needed 36 db, so that we have 14 db reserve gain.) We put these two units in the layout—the preamplifier at the antenna and the distribution amplifier in the office. Now we must check, since we have cascaded a pair of amplifiers, to see that we are not overloading the distribution amplifier.

This we can figure easily since we have already set our antenna at +10 dbj, which gives the preamplifier output as $10 + 25$ dbj $= 35$ dbj. The 60 feet of downlead has 3.6 db loss leaving a level of 31.4 dbj at the input to the amplifier. 31.4 db represents a ratio of about 37 times—meaning that we are hitting the distribution amplifier with 37,000 μv. The manufacturer says the maximum input signal is 5500 μv. We cannot use this setup unless we pad the downlead (use attenuators) to destroy most of the gain of the preamplifier! This is very wasteful. We must look further.

The manufacturer lists a distribution amplifier with 38 db gain, 2 db more than we need. This amplifier should have an input signal in the neighborhood of 1000 μv. but will accept

Blonder-Tongue MLA amplifier, with associated a.g.c. unit.

Jerrold 2300 amplifier provides adjustable gain and tilt.

up to 26,000. Let's see how it fits in.

We have a signal at the antenna which is 10 db over 1000 μv. The downlead will lose 3.6 db if we remain in coaxial cable, which we can do by using a matching transformer at the antenna. At the amplifier input, we will have a level of 6.4 db so that we meet input requirements, having at least 2000 μv. per channel at the input (6 dbj = 2000 μv.). The amplifier output will be 6.4 + 38, or 44.4 dbj. See Fig. 12.

Let us check the output limits. The manufacturer says his amplifier will deliver .3 volt per channel, with 9 channels in, so that it will certainly deliver more than this with only 3 channels. We need to convert our 44.4 dbj to microvolts to check this. The conversion table says that 44 db is about 150 times —or 150,000 μv., since 0 db is 1000 μv. This is .15 volt so that we are well below rated output. This appears to be the proper amplifier for the job.

Now we need to select the proper values of isolation for each tap along the feeder lines. The general rationale of this procedure is that the isolation be such that the set see a signal not less than 0 dbj in normal cases, nor less than 6 dbj where noisy conditions are expected, as in the hypothetical case we have described. We have also allowed 6 db "reserve" for tube aging. Therefore, if we use the maximum gain the amplifier has for our figuring, we should use an isolation value which will leave at least 12 dbj at the set when subtracted from the line level obtained at this particular tap-off unit. (This sounds as though it may be high, but 12 db is only four times, meaning 4000 μv. Remember that the db is not a linear unit. For example, 20 db is ten times and 40 db is 100 times a given value of input signal voltage.)

We can do this best by setting up a column of numbers (Table 3) starting with the input level of the feeder line. We can find this level by subtracting the splitter loss from the amplifier output level (Fig. 12), which gives us 41.4 dbj. From this point, we can determine the remanent (remaining) line level at each point by subtracting losses as they occur. We determined that the line length between tap-off units was 16 feet long. This represents a loss of 0.96 db (.16 × 6 db) which we had better call 1 db. Then, at the first tap we have lost 1 db in the line. We have a remanent level in the line of 40.4 dbj, as is shown in Table 3, after the first tap-off.

Since we are allowing 12 db total reserve, the maximum isolation loss we can stand is 40.4 − 12 = 28.4 db. At this point in the line, channel-2 signals will be only about 2 db higher than the channel-13 signals due to line *delta*, so that we must choose an attenuation value for the tap-off unit which will not be more than 30 db at channel 2. From Table 2, we find that a 2.2-μμfd. capacitor does this trick. The feedthrough loss at channel 13 with this value would be .15 db.

These figures give us the loss to the next unit, which will be 1.0 db line loss plus .15 db feedthrough loss, leaving a remnant line level of 39.25 db. We can proceed this way to the end of the line, checking the levels at channel 2 for only the first few taps. On following ones, extra line loss at channel 13 makes it unnecessary to check 2 again, since it will be higher than channel-13 signals. It will take us a total of ten operations to determine the value of the isolation in the tap-off units for the whole system. This system can correct for errors to a great extent, since the larger distribution amplifiers almost always have some form of gain control, usually a control for each of the two v.h.f. bands.

System Troubles

Although the development of a multiset system requires far more work and understanding than the maintenance and troubleshooting of one that has been built up, things can and do sometimes go wrong. Fortunately, systems of this nature are almost self-diagnosing. The symptoms are generally distinctive and indicative. To assist technicians who have not had much experience in this field, a list of symptoms follows, together with causes and checkpoints.

No pictures: Usually a dead amplifier; sometimes a parted antenna lead; but very rarely a broken cable. Shorted or open coaxial cables usually result in weak, ghosty pictures.

Ghosts that are not seen at the antenna lead: These are reflection ghosts due to open or mismatched lines. Characteristically they are ghosts whose placement and strength varies from set to set. They may only occur on one branch of a system. Check terminating resistors and cable connections.

Snowy pictures: Weak signals can be caused by open center conductor of coax; defective amplifier or tube. Misoriented antenna or parted antenna leads may be responsible. Check signal strength at inputs and outputs of amplifiers to pin down troubles.

Windshield-wiper effects, or overlaid pictures: This is cross-modulation caused by an overdriven amplifier. The point to watch is that the offending signal will be one that looks good itself. Remedy is to reduce the strength of the offending signal.

Sync instability: This is caused by overdrive. In single-channel amplifiers, overdrive will not show up as windshield-wiper patterns, but instead as sync-tip compression, causing the sets to be critical of sync adjustment.

Hum bars in raster of all sets past a given amplifier: Hum in power supply of amplifier. May be defective filters or cathode-heater short in tube.

Sound bars in all sets: Excessive level of sound carrier. Can be caused by misaligned amplifier or defective antenna.

Impact-sensitive flashing or flickering of pictures: Usually defective tube or loose connection. Usual locating techniques apply (shaking cables, tapping tubes).

Other troubles: Any installation is unique and "Finagle's first law" applies. This states that, in any experiment, if anything can go wrong, it will. You have our blessing! —30—

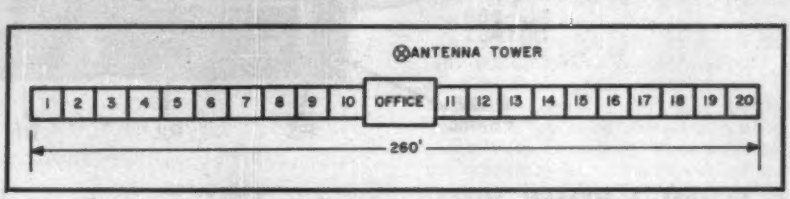


Fig. 13. Sample case: physical layout of a 20-unit motel with central office.

CAP. (μμfd.)	CH.2 I	CH.2 FT	CH.6 I	CH.6 FT	CH.7 I	CH.7 FT	CH.13 I	CH.13 FT
.47	42	*	34	*	33	*	29	*
1.0	34	*	26	*	26	*	22	.05
2.2	27	*	21	.1	17	.11	15	.15
3.3	22	.06	18	.12	14	.25	11	.5
5.0	19	.12	16	.2	11	.54	9	.9
6.8	16	.17	13	.3	9	.91	6	1.5
10.0	13	.3	9	.6	Not used in this band			

* = Insignificant loss; I = Isolation loss in db; FT = Feedthrough loss in db.

Table 2. Capacitor values commonly used in tap-off units, with their losses.

Table 3. How isolation values for the tap-off units are taken into account.

Starting level of feeder	41.4 dbj	
Line loss to first tap	1.0 db	
Line level at first tap	40.4 dbj	(less 12 db reserve = 28.4 db, required max. isolation*)
Line loss and feedthrough loss to next tap	1.15 db	
Line level at next tap	39.25 dbj	(less 12 db reserve = 27.25 db, required max. isolation*)

* N.B. Less isolation is permissible, more is not.

SSB EXCITER ATTENUATOR PADS

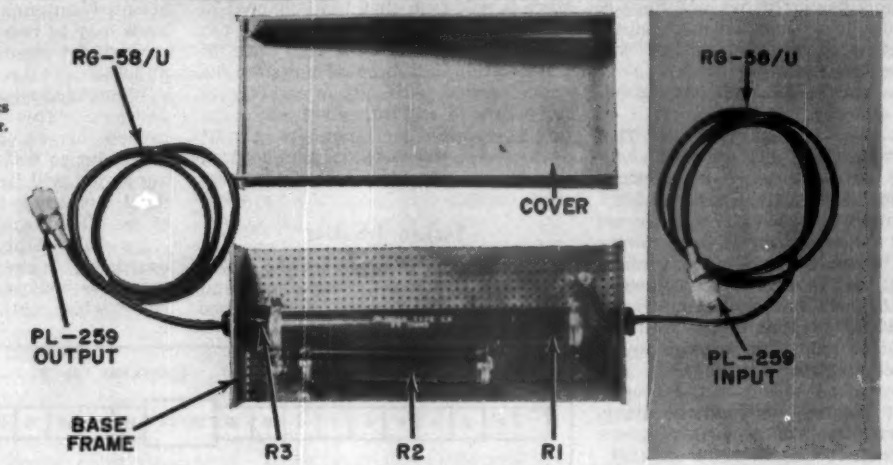


Fig. 1. A 9-db pad as constructed by author.

By **SAMUEL J. HYMAN,** W9VRX
Engineering Department
The Hallicrafters Co.

A pad between exciter and amplifier improves carrier suppression and signal-to-noise, reduces distortion.

SINGLE-SIDEBAND transmission is no longer considered a new fad in ham radio. Its advantages relative to solid "QSO's," reduced "QRM," and the realization of equivalent high AM power with smaller tubes and power supplies are no longer questioned.

Most single-sideband exciters, whether purchased or home-built, have an output power range from ten to one-hundred watts. When a linear amplifier is added after the exciter and using the FCC method of measuring sideband input plate current, it is possible to obtain over 800 watts of sideband power output directly into the antenna.

When a linear amplifier is driven by a single-sideband exciter, it is possible to overlook an important consideration. How should the exciter output be reduced to the proper drive level for the linear amplifier?

The simplest and most readily available method is to reduce the microphone gain by adjusting the microphone gain control.

Too often we may advise someone that he has a considerable amount of carrier present. You volunteer to run tests for him. First, his exciter, barefoot, sounds good. But when he switches to his linear amplifier, up pops his carrier again.

This disturbs him no end. He may not understand the cause. The only difference between running his exciter barefoot *versus* exciter plus linear-power amplifier was the reduction of his microphone gain in the latter case.

Simple, yes, but that was his big mistake. Let's get a little technical and perhaps you will get the idea.

It is easier to understand an analysis if extreme cases are considered. So, let's consider a sideband exciter capable of delivering 100 watts of sideband power output. We will also consider a linear-power amplifier that will require only 10 watts of driving power to develop full power output. The power output of the linear amplifier, for our discussion, will be 800 watts.

Let's look into our exciter first. The specifications tell us that at the 100-watt single-sideband output level, the carrier is suppressed 50 db. This figure was obtained using the "two-tone" test method. This is an excellent method for laboratory test purposes. It permits tests and comparisons to be made with good accuracy and capabilities of repeatability.

When the exciter is in actual use, the human voice is involved. Unfortunately, the human voice is not a constant-amplitude source. The exciter under discussion does not have any special circuits for speech clipping or amplitude compression thus, we must set our microphone gain control so that our voice peaks do not clip and distort. This moves our effective output power for speech purposes to about a 60-watt level and our carrier is now suppressed below this level by 47.8 db.

We now reduce the power output from the exciter by reducing the microphone gain so that the peak-envelope-power is only 10 watts. The carrier (−50 db at 100-watt level = 0.001 watt) level has not changed. It is still 0.001 watt or now [$db = 10\ log\ (P_1/P_2) = 10/.001$] it is suppressed only 40 db.

We now realize a loss of 10 db of carrier suppression by using our microphone gain control to reduce the exciter drive to the linear amplifier and, with speech present, the carrier is down only 37.8 db.

There is another point to consider. The carrier suppression is partially or wholly dependent upon the balanced modulators. The balanced modulators are dependent upon their inherent circuit stability. Unfortunately, there is a warm-up period required. When the exciter is first turned on, it is not uncommon to have only 30 db carrier suppression.

The warm-up period for the carrier balance to settle down may range from 15 minutes to 2 hours. During this period, the suppression may start at 30 db and may never get down to 50 db. Without additional adjustments within the exciter, it is possible for the final warm-up suppression to be only 40 db.

This is not objectionable if we use the exciter barefoot. But if the exciter is used to drive a linear amplifier, as previously discussed, there would be an additional 10 db lost and the carrier suppression would be only 30 db.

But most of us would not wait one to two hours for the rig to warm up before going on the air. Therefore, it is possible to have only 30 db carrier suppression in the exciter during the first "QSO" and better suppression as the rig is used continuously, *i.e.* without being turned off.

Again, using the microphone gain control to adjust the drive to the power amplifier, only 20 db carrier suppression can be realized. This is not good, is it? With speech, it's down only 17.8 db.

Now, let's look into the exciter a lit-

tle farther. We find mixers, i.f.'s, oscillators, class A amplifiers, both r.f. and audio, and an audio gain control. Sounds like we are describing a superheterodyne receiver. Well, they are similar.

Just as there is a signal-to-noise ratio in the superheterodyne receiver, there is also a similar signal-to-noise ratio in the single-sideband exciter. These noises are inherent. They are developed within the vacuum tubes and associated circuitry. Hum is also considered as a noise component.

The signal-to-noise ratio is unaffected by the volume control in the receiver but the signal-to-noise ratio is affected by the microphone gain control in the exciter.

The noise in the receiver is overridden or swamped out when a strong signal is received. The exciter is similar in this respect. However, we can control the desired signal ourselves. The microphone gain control is adjusted for maximum signal output at a point where the distortion products are not undersirable.

Now, the undesirable noise in the exciter can become audible in our transmitted signal if the microphone gain control is used as the means of reducing the excitation to the linear amplifier.

We can take full advantage of the carrier suppression within the exciter with no loss and keep the signal-to-noise ratio at a maximum by using a fixed pad between the exciter and the power amplifier. The pad forces the exciter to operate at near maximum output and attenuates the output to the proper drive level for the power amplifier requirements.

We cannot overlook another advantage when a pad is used. It permits the exciter to work into a "stiff" load which means that the distortion products developed in the final stage remain at their lowest level. This is particularly true if the final power amplifier is operating class B.

Now, let us go through a typical pad design. The most common and most popular pad used today is the "T" type. See Fig. 2.

In this diagram Z_s = impedance of the source and Z_L = impedance of the load—both of which should be considered as pure resistance. R_1 and R_3 are the "T"-pad series arms while R_2 is the "T"-pad shunt arm.

With this information we can set up the following formulas for determining values:

$$R_2 = \frac{2\sqrt{N Z_s Z_L}}{N-1}$$

$$R_1 = Z_s\left(\frac{N+1}{N-1}\right) - R_2$$

$$R_3 = Z_L\left(\frac{N+1}{N-1}\right) - R_2$$

$$N = \frac{\textit{power delivered to pad}}{\textit{power delivered to load}}$$

Thus, where $Z_s = Z_L$, then $R_1 = R_3$.

Here is how we would compute the "T"-pad to be used with the exciter—linear-power amplifier discussed in this article. Assume that the exciter power output is equal to 100 watts; power amplifier drive required is 10 watts; power delivered to the pad is 100 watts; and Z_s and Z_L are 50 ohms. First we will compute "N."

$$N = \frac{100}{10} = 10$$

Next, we compute the value for R_2:

$$R_2 = \frac{2\sqrt{10\times50\times50}}{10-1} = \frac{2\sqrt{25000}}{9} = 35 \text{ ohms}$$

R_1 and R_3 are computed as follows:

$$R_1 \text{ and } R_3 = 50\left(\frac{10+1}{10-1}\right) - 35$$

$$= 61 - 35 = 26 \text{ ohms}$$

The circuit derived from these computations is shown in Fig. 3.

To compute the power dissipated in each resistor in the pad, the circuit can be redrawn as shown in Fig. 4. The formulas then become:

$P_{R_1} = I_1^2 R_1 = (1.42)^2 \times 26 = 52$ watts

$P_{R_2} = I_2^2 R_2 = (.972)^2 \times 35 = 33$ watts

$P_{R_3} = I_3^2 R_3 = (.448)^2 \times 26 = 5.2$ watts

This totals 90.2 watts. The power figure would be exactly 90 watts if the decimals were carried out farther.

We have now completed our design. For safety reasons, we increase the power ratings of the resistors, as indicated in Fig. 5.

The chart of Table 1 gives values for the series-arm and shunt-arm resistances at various desired attenuations. These are not exact values but since the errors involved are small it makes very little difference in the final result.

The resistors used in the pad construction must be non-inductive. Non-inductive resistors should not be unknown in our hobby. Actually the most common type is the "carbon" resistor. There are, however, special wire-wound resistors which are made specifically as "non-inductive" types. Among the firms making this type of resistors are: *International Resistance Corp., Ohmite,* and *Sprague.*

Again, we would like to stress that only non-inductive resistors should be used in these pads. As we know, inductances are coils, chokes, and transformers. They have a reactance or a.c. ohmic value which is dependent upon the frequency at which the inductance is being used. Further, these inductances have self-resonant frequencies. When the distributed capacity within the coil has a reactive value equal to the inductive-reactance value, resonance occurs.

It is often necessary to connect several resistors in parallel to obtain adequate dissipating capabilities. The power dissipation of the parallel group is equal to the sum of the power dissipated by each resistor in the group. The easiest way to ascertain the proper ohmic value for each resistor in the parallel group is to use resistors of the same resistance value. Then, the final ohmic resistance value for the parallel group is equal to the resistance value of one resistor divided by the number of resistors used in the group.

In this particular application, the resistors may have a ± 10% tolerance.

Taking the time to compute and construct the correct "T"-pad for your rig will pay off in operating convenience and a clean signal. -30-

DESIRED ATTENUATION (db)	SERIES-ARMS RESISTANCES (ohms)	SHUNT-ARM RESISTANCE (ohms)
2	5.8	215
3	8.6	140
4	11	105
5	14	82
6	17	67
7	19	56
8	22	47
9	24	40
10	26	35

Table 1. Resistances for various attenuation between 50-ohm source and load.

Fig. 2. Shown at the right is the basic diagram of the "T" pad with its source and load impedances illustrated.

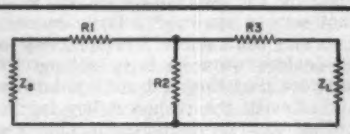
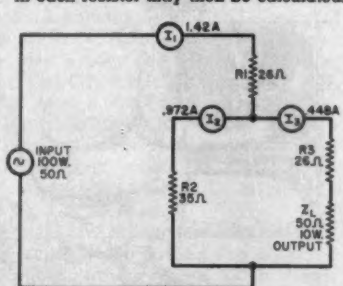


Fig. 4. The basic attenuator pad circuit has been redrawn here and the power in each resistor may then be calculated.



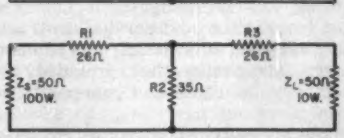
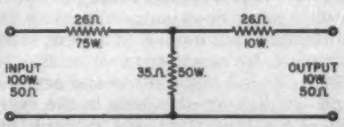


Fig. 3. Values of resistors used in pad.

Fig. 5. Final circuit design described.



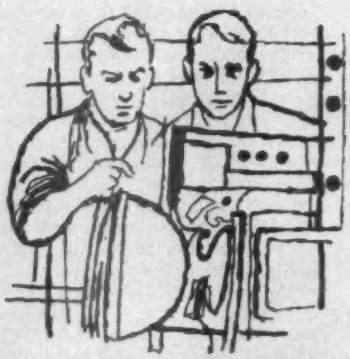
the NEW LOOK IN TV SERVICE

By WILLIAM LEONARD

The younger generation of TV service dealers reflects change in the nature of the industry.

THE MOST interesting and potentially important factor in the independent electronic service industry of today is the dynamics of youth evident in the direction of TV service businesses. Seasoned observers, who have watched developments in electronic service over a period of years, have been deeply impressed by the number of young men who now operate their own TV service businesses. It is apparent from their participation in association activities that these young men are determined to have a hand in shaping the future of their industry.

To appreciate the significance of "youth in the saddle" in electronic service management, it is necessary to



review the history of the activity since the introduction of television.

During the early days of TV, contract service spawned a large number of service contractors. The majority of set dealers were so busy selling TV receivers that they did not want to be saddled with the responsibility for installing and servicing then. The prepaid installation and service contracts were assigned to selected, independent service companies that provided the necessary facilities and manpower to carry them out.

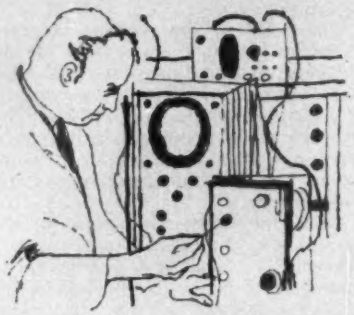
The majority of these service-contractor businesses were completely financed by the monies received for prepaid service. The tremendous volume of business available to them encouraged over-expansion. Service organizations that employed fifty or more men were not uncommon.

The prepaid installation and service-contract plan hit the skids in the early fifties. By that time, the competition for TV set sales had become so intense that many non-servicing dealers sold receivers at close to their own costs and chiseled their profit out of the contractors who handled service for them. This situation, coupled with poor financial management, pushed many service contractors into bankruptcy. The failure of these service contractors left thousands of set owners out on a limb for the service they had paid for when they bought their sets.

During this same period service gyps, fly-by-nights, and incompetents were fleecing the public without restriction. The Better Business Bureaus across the country were swamped with complaints about raw deals on TV service. The failure of many TV service contractors fanned the flames of public resentment against all independent TV service shops.

Concurrently with these developments, thousands of men who had converted their radio service businesses to handle TV service were quietly building a strong foundation of honest, ethical TV service businesses. Since they were basically technicians, they confined their efforts to servicing sets that were out of the area of contract service. They had a tough problem of customer relations because set owners were inclined to show little respect for *any* TV service dealer or technician.

While television was floundering about, electronic developments in an expanding national defense program reached out with attractive offers to practically every competent technician in the industry. There was some feeling that other electronic activities would drain the service industry of most of its competent technicians and completely



absorb the graduating classes of trade schools, leaving the independent service industry with only a skeleton organization to handle the growing business of consumer service.

Two forces were at work, however, that would have a strong bearing on the future of independent service. Ambitious technicians who acquired practical experience as employees of dealers or service contractors started their own service businesses. Most of these men enjoyed the business, had a flair for promoting service, and a knack for handling customers. They stepped into their businesses at a time when economic conditions favored the small, low-overhead businesses.

The other force was made up of the trained and skilled technicians who left the regimented life of military service and sought some business opportunity that would give them freedom of thought and action. In various ways, many of these energetic and ambitious young men got into the business.

The outstanding characteristic of this younger generation of service dealers is the objective approach they use in solving their management problems. They view TV service as a business and are quick to take advantage of plans and ideas that appear to be sound for their businesses. In contrast, their counterparts in radio service in years gone by depended more on their technical capabilities than on their business management "know-how" to stay in business.

On the whole, the service industry nationally has been passing through a period of economic re-adjustment and mental transition. In the wake of the former, there has been a sharp reduc-

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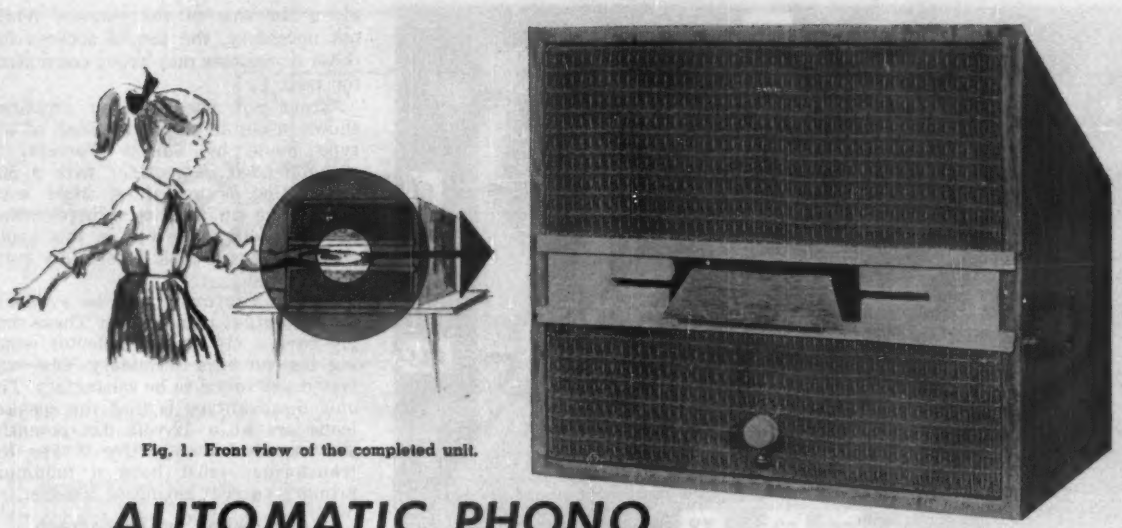


Fig. 1. Front view of the completed unit.

AUTOMATIC PHONO WITH TRANSISTOR AMPLIFIER

Compact child's phono uses a.c.-operated 1½-watt transistor audio amplifier and 45 rpm record player.

By **KENNETH W. BETSH**

AN a.c.-operated 1½-watt transistor audio amplifier and an *RCA* "Slide-O-Matic" 45 rpm mechanism are combined to make a small, compact phonograph designed especially for children. Not requiring a warm-up time, music starts the moment a record is inserted in the slot and the "play" bar is raised. A front view of the phonograph, housed in a cabinet built by the author, is shown in Fig. 1.

There are several reasons for using a transistorized amplifier in this type of phonograph. Besides requiring no warm-up time, there is no shock hazard since power is derived from a 12-volt filament transformer. A compact, totally enclosed cabinet can be used since practically no heat is radiated by the amplifier. Because inexpensive transistors are used, the parts cost compares favorably with that of an a.c.-operated vacuum-tube amplifier; the use of an a.c.-d.c. amplifier by children being ruled out. Last, but not least, there is the experience with transistor circuits to be gained by constructing this unit.

The *RCA* mechanism, priced quite reasonably, has been on the market for some time. Finding one at a dealer or buying one second-hand should not be too difficult. Many stores are now offering these units at drastically reduced prices.

The schematic of the amplifier is given in Fig. 3. Since the circuit may seem unusual to one whose experience has been limited to tube-operated equipment, a detailed explanation of its operation will be given.

The amplifier contains four transistors: three are 2N229's, and one, the output stage, is a 2N307. When this amplifier was designed, these were the cheapest available, the total cost being $3.75 for all four. The 2N307 is one of the types designed for 12-volt automobile radios, therefore a 12-volt d.c. power supply is used. Oddly enough, unlike vacuum-tube circuits, the 12-volt supply is made negative with respect to the chassis ground of the unit.

The crystal pickup used in this player delivered about 0.3 volt from a frequency test record. This was measured across the 180,000-ohm load resistor wired across the pickup leads. The response, again using a test record, was found to be very close to the RIAA curve from 200 cps to almost 10 kc. The roll-off below 200 cps is due to the load resistor. This was found desirable to control the rumble reproduced by the pickup and to limit the resonance of the 4" x 6" oval speaker when mounted in the cabinet.

Like all crystal pickups, the frequency at which roll-off occurs goes up as the value of the load resistor is reduced. With the very high input resistance of a vacuum-tube amplifier, this load resistor is placed in parallel with the tube input. A transistor, however, has a very low input resistance. As a result, the load resistor, R_1 in Fig. 3, is in *series* with the transistor input. While this reduces the signal voltage to the first transistor, the signal current, which is just as important, is not reduced. C_1 is used to provide d.c. isolation.

The 2N229 transistors are of the *n-p-n* type, which means the collector (analogous to the plate of a tube) is positive with respect to the emitter which is analogous to the cathode. The arrows of the transistor symbol show the positive-to-negative current flow. Since a negative voltage supply is used, the collector load resistors (R_3 of the first stage and R_7 of the second) are tied to ground while the emitters are tied directly to the power supply. This arrangement simplifies wiring and eliminates the possibility of destroying a transistor by accidentally shorting any transistor lead to the chassis.

To get collector current to flow, bias resistors R_2 and R_6 are used. This bias current is taken through the collector load resistors to obtain two feedbacks —d.c. to aid in stabilizing the collector current and a.c. to reduce noise and distortion.

The first and second stages are used as common-emitter amplifiers in which the base is the input and the collector is the output. C_2 couples the first stage to the volume control R_4. This control can be of almost any value over 10,000 ohms, and should preferably be of the audio taper type. Notice that the sliding and high-end terminals are connected just the reverse of those used in vacuum-tube amplifiers. The combination of R_5 and C_4 gives a fixed amount of bass boost in the 500 cps area to offset the lack of low-frequency response and to give a balanced sound at normal listening levels that may be used.

The signal is coupled by C_5 to the third stage which is another 2N229. This transistor is connected as a common-collector amplifier to act as a direct-coupled driver to the output stage. Bias current for the driver flows through R_{10}. The value of R_{10} is such

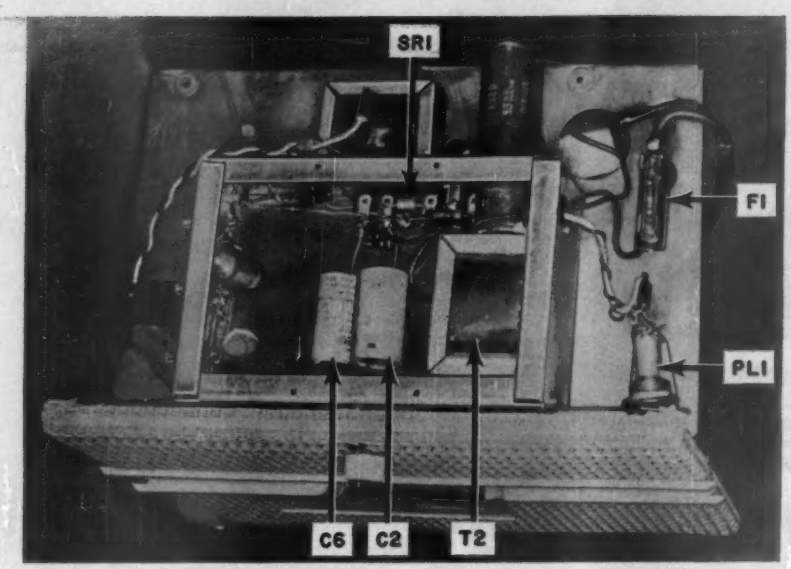


Fig. 2. Bottom view of phono shows placement of the rectifier and other components.

that, with no signal, half the current goes through the driver and the other half through the base of the output stage. As an incoming signal increases the base current of the driver, its collector current (and also the emitter current) is increased. This increases the voltage drop across R_{10}. As a result, the base current of the output stage is proportionately reduced.

Since the current through R_{10} determines the collector current of the *p-n-p* output stage, its value has to be definitely set. With the average 2N307, a value of 1000 ohms results in a collector current of 600 milliamperes if the driver is cut off. With the driver collector drawing proper current, the 600 ma. falls to 300 ma. R_{12} is required to allow sufficient operating voltage for the driver since the base-to-emitter voltage drop of the output stage is a fraction of a volt.

The output transformer, T_1, is connected between the collector of the output stage and the negative power supply. It should have a primary impedance of 24 to 32 ohms.

The power supply consists of a 12.6-volt filament transformer, a 500 ma. rectifier, three resistors (R_9, R_{11}, and R_{13}) and three capacitors (C_2, C_3, and C_7). The purpose of R_{13} is to limit the peak current drawn through the rectifier to charge C_7. This unit has sufficient capacity to smooth the d.c. for the output-stage collector. It is not filtered enough, however, for the output-stage base current. The advantage of the negative power supply is that the base current alone can be given additional filtering much cheaper than if all the current drawn by the output stage had to be well filtered.

The filament transformer used by the author had a center tap, so a 6.3-volt pilot lamp was wired in. It was so bright that a 10-ohm series resistor, R_{14}, was added. This should prolong the life of the bulb. A ¼ amp. fuse was placed in the transformer primary as a safety precaution. In case of a circuit defect it won't save the transistor from burn-out (since they can burn out faster than a fuse) but it could save a rectifier or transformer. No power switch is shown since the motor switch on the record player is used to turn the amplifier on and off.

Construction

This amplifier was constructed on a 4" x 6" x 2" aluminum chassis. It was constructed in a "pancake" arrangement with all the parts around the edges of the chassis and none on the top. This kept the height of the finished unit to two inches. Two views of the chassis after being bolted to the record player are shown in Figs. 2 and 4.

The power transformer is placed inside the chassis. The transformer should have a 12.6-volt secondary. While the current drain is about one-half an ampere, the only readily available types have much higher ratings.

The output transformer is on the outside mounted between the large filter capacitor, C_7, and the output transistor. This transistor, like all others of its type, has its collector internally connected to the case. This is so that the heat generated at the collector can be conducted away. In addition, the transistor must have its flat surface mounted against a heat sink which can be the chassis. However, since the circuit will not permit grounding of the collector and operation without a heat sink is risky, a problem exists. The answer is a transistor mounting kit made by *Bendix* which is available from *Lafayette Radio*. It contains an anodized aluminum plate (the anodizing making the surface an insulator), two insulated mounting bushings, and a socket for the base and emitter leads.

The other transistors are mounted along the side of the chassis. While not necessary, the use of sockets for these transistors may prove convenient for testing.

While not used in the amplifier shown, a clip-in silicon rectifier, of the type made by *Sarkes Tarzian*, is recommended. A rectifier with a 500 ma. rating is necessary. Most such units have an inverse voltage rating of 250 to 400 volts, but in this application a 30 volt peak is certainly quite adequate.

Autotransformers may be available for the output transformer. These simply have a tap on the collector winding instead of a secondary. One was tested and found to be saisfactory. The only disadvantage is that the speaker leads are at a 12-volt d.c. potential above ground. Irrespective of type, the transformer must have a minimum primary current rating of 300 ma.

Completing the Phonograph

The *RCA* "Slide-O-Matic" comes in a shallow plastic case with an audio lead for plugging into a separate amplifier. The author discarded both the plastic enclosure and the plastic front piece. A new wooden front was made and the player was attached by using right-angle brackets between it and the copper-plated base plate of the mechanism.

The wooden panel extends below the base plate the same amount as the height of the chassis, *i.e.*, two inches. A self-tapping screw through the front panel just below the volume control and two screws between the chassis and the base plate hold them together. The speaker, a 4" x 6" PM type, is screwed to the front panel above the slot. This slot is cut in much the same way as the cut-out of the original plastic piece.

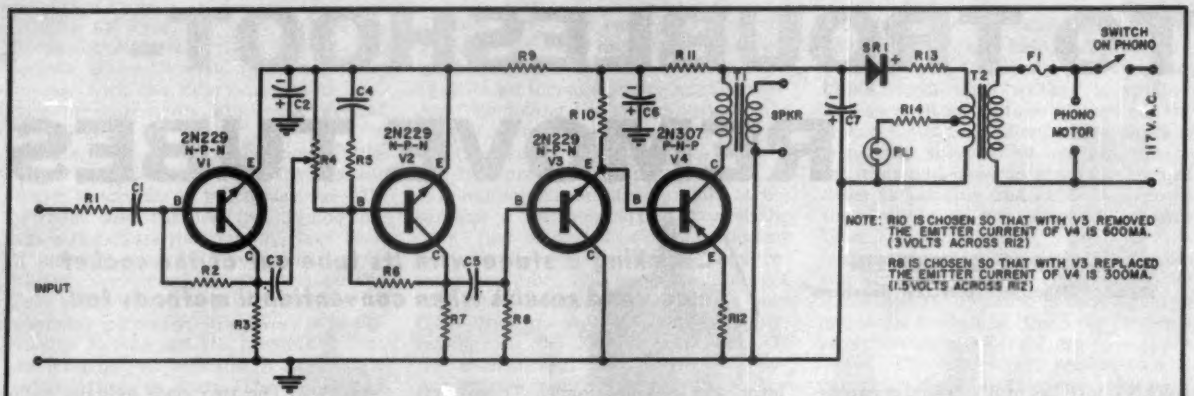
This assembly is installed in the new cabinet from the front. It is held in place by a large self-tapping screw which runs through the back of the cabinet and into a bracket on the mechanism. Care must be taken to avoid excessive screw length since this would block the shut-off operation.

The cabinet shown in the photographs was made of plywood. Half-inch wood was used for the ends and quarter-inch for the rest. All except the front is covered with "Contact" in a simulated blonde mahogany finish. Other designs and simulated wood finishes are available and can be selected to match a child's bedroom or play area color scheme.

Many cabinet variations are possible. For greater simplicity, the mechanism in its original enclosure could be bolted to a matching box containing the amplifier and speaker. This, however, would not be as durable under a child's handling.

Testing

Builders having access to a voltmeter can make a few measurements that will insure proper operation. Before turning the amplifier on, it is wise to check with an ohmmeter to see that



R_1, R_3, R_6—180,000 ohm, ½ w. res. ± 10%
R_2, R_7—8200 ohm, ½ w. res. ± 10%
R_4—10,000 to 100,000 ohm audio taper pot (see text)
R_5, R_{10}—1000 ohm, ½ w. res. ± 10%
R_8—6800 ohm, ½ w. res. ± 10%
R_9—390 ohm, ½ w. res. ± 10%
R_{11}—180 ohm, ½ w. res. ± 10%
R_{12}—5 ohm, 2 w. res. ± 10%
R_{13}—1 ohm, 1 w. res.
R_{14}—10 ohm, 1 w. res. ± 10% (see text)

C_1—.1 μfd., 12 v. min. capacitor
C_2—100 μfd., 15 v. elec. capacitor
C_3, C_5—1 μfd., 12 v. min. capacitor
C_4—.25 μfd., 12 v. min. capacitor
C_6—50 μfd., 15 v. elec. capacitor
C_7—1000 μfd., 15 v. elec. capacitor
PL_1—#47 pilot light
F_1—¼ amp. fuse
SR_1—500 ma., 30 v. peak-inverse-voltage (min.) silicon rectifier (Sarkes Tarzian 10M or M500 can be used)

T_1—Transistor output trans. 24-32 ohm primary to 3.2 ohm v.c., 300 ma. minimum primary current (Microtran M2376 or equiv.)
T_2—Fil. trans. 12.6 v. c.t. @ 2 amps. (Stancor P-8130 or equiv.)
1—4" x 6" x 2" chassis
V_1, V_2, V_3—"n-p-n" transistor (Sylvania 2N229)
V_4—"p-n-p" transistor (Sylvania 2N307—Mounting kit for this transistor available as Bendix No. 210-6300)

Fig. 3. Complete schematic diagram and parts listing for the transistorized phonograph amplifier discussed.

the output transistor is properly insulated.

After turning on the unit, measure the voltage across R_{12}. Since it should be 5 ohms, by Ohm's Law E should be 1.5 volts if 300 ma. is flowing. If this reading is over 4 volts, turn the amplifier off immediately and check for errors. With power off, disable the driver by either unplugging that transistor or by shorting its base to emitter. Turn the unit on briefly and measure the same voltage. It should be double, or 3 volts. If not, change R_{10} to give a reading of 3 volts. Increasing the value of the resistor will decrease the voltage. Once this is set, restore the driver, and if the voltage doesn't drop to one-half, change the value of R_8 until it does. In this case increasing the resistance will increase the voltage.

As is the case in almost all transistor circuits, the voltage between the base and emitter is a fraction of a volt. The collector voltage of the first two stages should be between 5 and 9 volts to ground. A suspected defective output transistor can be checked with an ohmmeter. Checking base-to-emitter or base-to-collector should show a low resistance with one connection of the meter leads and a high resistance when reversed. The emitter-to-collector resistance should be high in either case.

Parts Substitution

All the resistance values in this circuit are fairly critical and changes, except where measurements show otherwise, should not be made. Capacitor values are not, however, critical. Decreasing their values will only affect frequency response or the hum level.

As far as substituting other transistors is concerned, changes from *n-p-n* to *p-n-p* cannot be made without interchanging the positive and negative voltage connections and the polarity of the electrolytics. Even if other *n-p-n* transistors are substituted for the 2N229's, it probably will be necessary to change the bias resistors, R_2, R_8, and R_6. However, as long as the voltages read as indicated previously, the substitutions are all right.

All power transistors now manufactured are of the *p-n-p* variety and other types could be substituted. Most of the others are more costly, although they have higher current gains. This means that the value of R_{10} would have to be increased to keep the collector current at 300 ma.

This amplifier has plenty of gain even w. h the relatively low-output crystal pickup. With some of the high output crystal cartridges that put out several volts, the first stage probably could be eliminated by tieing C_1 directly into the volume control.

Conclusion

Everyone has commented favorably on the instant-playing feature and the quality of sound put out by this unit. Needless to say, it won instant approval with the children. The automatic shut-off is appreciated by the parents who have often had to turn off a non-automatic record player after the children have started it and then walked off and ignored it.

The author wishes to thank his associates at *Bendix Radio Division* for their advice and for the photography. This project was, however, original with the author and does not represent any product or idea of his company.

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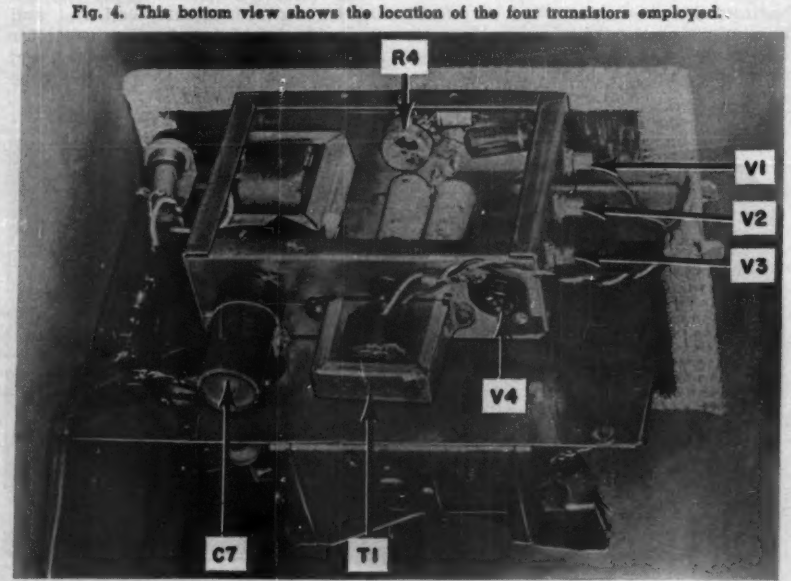
Fig. 4. This bottom view shows the location of the four transistors employed.



TO TROUBLESHOOT-REMOVE TUBES

By **CYRUS GLICKSTEIN**
Author, "Repairing Television Receivers"

Checking a stage with its tube out of the socket may yield results when conventional methods fail.

MANY KINDS of TV troubles can be located faster by first removing a tube in the stage thought to be faulty, then checking the stage. That's right—checking the circuit while the tube is *out*. Obviously, this procedure is somewhat different from the standard TV practice of removing tubes suspected of being defective and substituting good tubes.

This is not meant to imply that tube substitution is no longer necessary. Replacing tubes which may be bad is still one of the first and most important steps. However, once it has been found that the trouble in the set is not caused by a defective tube, other troubleshooting steps are obviously required. Tube removal is simply one of these other methods and can be very helpful, especially for some tricky faults such as intermittents and tough troubles in the sweep and horizontal a.f.c. circuits.

Surprising as it may seem, this method can be used to locate various troubles in series filament sets. Several examples will show how useful this procedure can be.

Case No. 1. An intermittent Christmas-tree effect was noted on the screen (Fig. 1), with the picture and raster breaking up horizontally. The set was an *RCA* chassis KCS-102B—a transformer-type receiver. Control adjustments and tube substitutions in the horizontal sweep circuit had no effect in eliminating the trouble. The chassis was pulled and d.c. voltage readings were taken around the horizontal oscillator and output stages. These were found to be within the normal tolerance of the voltage readings noted on the schematic. Oscilloscope patterns around the horizontal sweep circuit appeared to be normal.

Since the fault was evidently a horizontal frequency defect, the oscillator tube was removed. Power was reapplied to the set and voltage readings were again taken around the stage (Fig. 3). The following readings were obtained: Pin 1, 240 volts; Pin 2, 1 volt; Pin 3, 3.5 volts; Pin 6, 240 volts; Pin 7, 5 volts; and Pin 8, 0 volts.

With the tube removed and no current flowing through the cathode-plate circuits, zero voltage would normally be expected on pins 2 and 7 (grids) and pin 3 (cathode of the control tube). Positive voltages on these pins indicates a leaky capacitor. Since all of these pins are interconnected through a resistive network, it was quite likely that all of the positive voltages were due to a single faulty part. Inasmuch as the highest unexpected positive voltage was measured on pin 7, it was probable that this pin was closest to the defect and the lower voltages on pins 2 and 3 were due to the voltage-divider effect of the resistive network.

The only possible source of the higher positive voltage applied to pin 7 was a leaky capacitor, C_{130}, connected between the horizontal-frequency coil, L_{108}, and the control grid (pin 7). The capacitor lead to the control grid was clipped and the voltages rechecked with the tube still out. The two grids and the cathode now measured 0 volts. Replacing the capacitor with a new one resulted in normal operation.

A point to keep in mind is that a small amount of leakage may occur in some "intermittent" capacitors even during periods when the set seems to be operating normally. Especially in oscillator stages, the leakage may not be sufficient to affect voltage readings beyond the usual tolerance. In a horizontal-oscillator stage, for example, practically every pin has a substantial positive or negative voltage with the tube in the circuit, thus a small amount of leakage may not affect the readings enough to point to the defect. Yet, with the tube out of the circuit, the small amount of leakage can be detected immediately if one or more pins which should then have *no* voltage reading should show positive voltage.

Exactly the same procedure can be followed if a similar trouble occurs in a series-filament set. The tube is removed and voltages measured around the stage. True, removing one tube in a series-filament set opens the filament string and no tubes light. However, these sets usually have selenium-rectifier low-voltage power supplies, and "B+" voltage is generated as usual even with no heaters lit. A leaky coupling capacitor shows up in this type of set in exactly the same way as in the transformer type.

One precaution is worth noting. In some horizontal oscillator circuits, there is a small amount of positive voltage fed back from the plate circuit to the control grid of the horizontal oscillator to reduce the amount of negative voltage on the grid (R_1, Fig. 2). With the tube removed, feedback resistor R_1 normally would place a positive voltage on the grid pin which would mask any capacitor leakage. This can be eliminated during a tube removal check by unsoldering one end of R_1 before making the voltage check around the tube socket with the tube out.

A set may have an intermittent trouble which doesn't show up when measurements are made with the tube removed. The standard procedures for breaking down the intermittent should then be followed—warm air from a hair dryer applied to the stage, placing a heated soldering gun under a suspected part for a short time, and so on

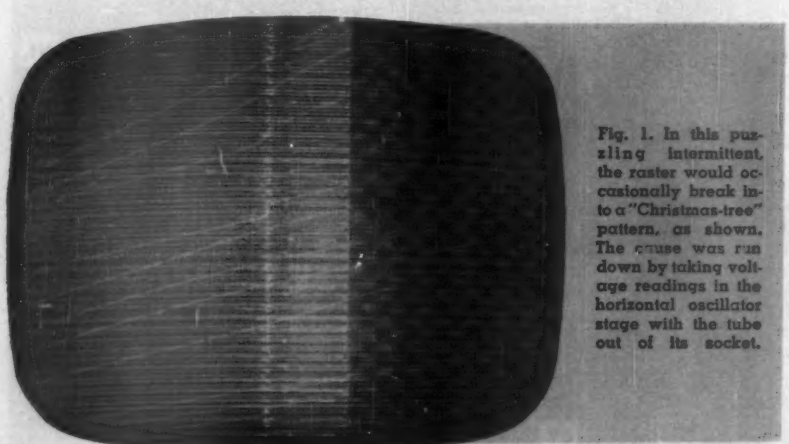


Fig. 1. In this puzzling intermittent, the raster would occasionally break into a "Christmas-tree" pattern, as shown. The cause was run down by taking voltage readings in the horizontal oscillator stage with the tube out of its socket.

—with the tube still out. If an oscillator-circuit capacitor, for example, becomes leaky, it will often show up sooner with the tube removed as voltage measurements are made around the circuit.

Case No. 2. When a fuse blows in the "B+" or horizontal-output circuits, the usual procedure is to replace the fuse without any further troubleshooting, since the cause may simply have been a current surge. In many cases, no further servicing is necessary after the fuse is replaced and it is found the set operates normally. However, it is advisable to rule out the possibility that an intermittent breakdown caused the original fuse to open. The set should be run for a short time with a higher-than-usual voltage after the fuse is replaced. This is done most readily in power-transformer sets by removing the sound-output tube before turning on the power. This reduces the load on "B+," causes an increase in the low-voltage "B+," and consequently in the boosted "B+" and high voltage as well. An intermittent is more likely to show up with an increase in the applied voltage. Removing the sound-output tube therefore serves to check for a possible intermittent in either the "B+" line or the horizontal-output circuit.

A similar check can be made to determine if an intermittent caused the "B+" fuse to blow in a series-filament set. Simply replace the fuse and remove one tube. This opens the filament string and removes the complete load from the low-voltage power supply, raising the "B+" voltage output. If the intermittent part is in the low-voltage power supply proper, the higher "B+" voltage will, in many cases, cause it to break down.

Case No. 3. If a blown fuse is replaced and then the replacement fuse blows, this can become a rather involved trouble to find. The blown replacement fuse definitely points to trouble in the set. Resistance checks very often do not help in finding the trouble, since the faulty part may not break down until voltage is applied. Yet as soon as voltage is applied, the replacement fuse blows. The problem is usually resolved by applying methods that will blow as few replacement fuses as possible and still track down the trouble in the shortest possible time.

One conventional method is to disconnect the complete load from the fused circuit. The fuse is then replaced and each branch of the load progressively reconnected until the fuse again blows. The last circuit reconnected is generally the defective one. Unfortunately, this technique is slow and painstaking.

In transformer-type sets with horizontal-output fuse trouble, it may be possible to localize the defect quickly by first removing the horizontal-output

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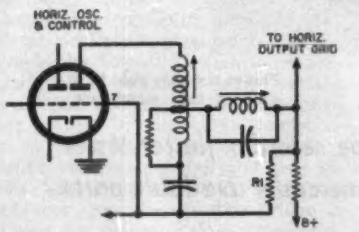


← Fig. 2. Feedback resistor R_1 normally reduces negative voltage on pin 7, but applies positive voltage when the tube is removed.

Fig. 3. Horizontal oscillator and control stage for the RCA KCS-102B. →

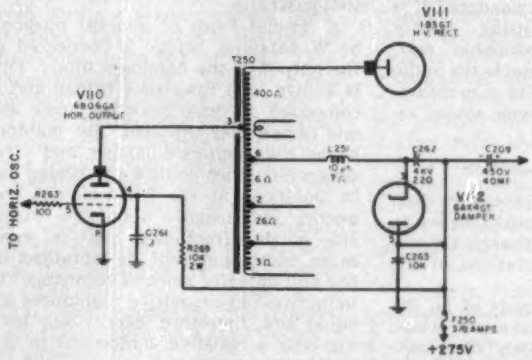
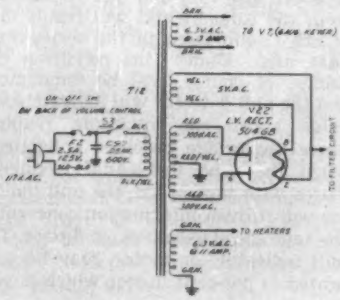
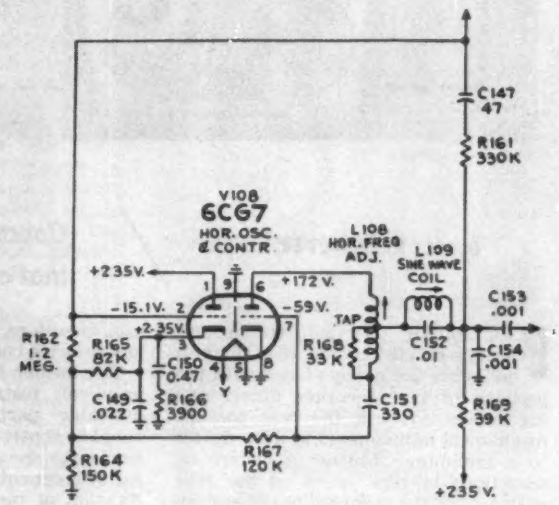


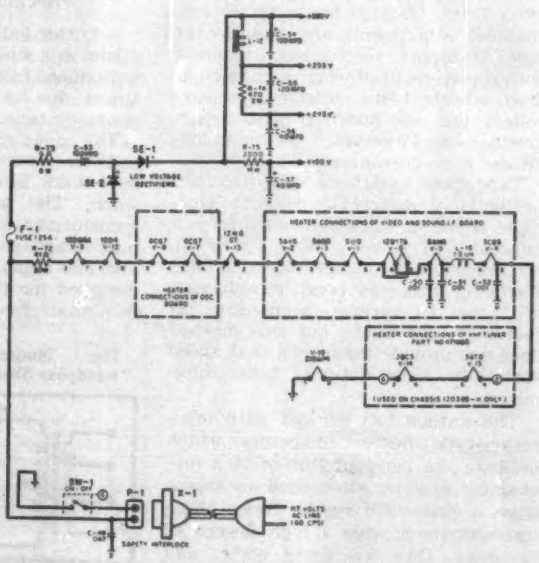
Fig. 4. Fused horizontal-output circuit, used in G-E "U" line.



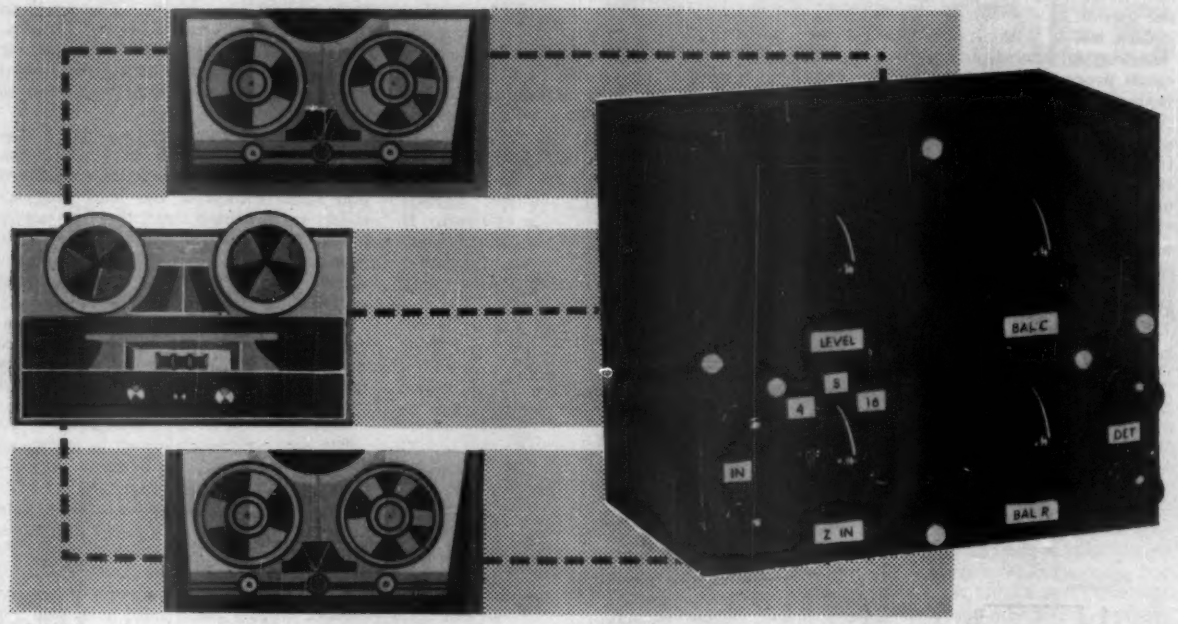
← Fig. 5. Fuse (F_3) in primary circuit of a transformer-powered receiver (Andrea VQ21 series).

Fig. 6. Fuse (F_1) as used in the "B+" supply of a series-filament receiver (Emerson 120380H). →





Measure That Flutter



Flutter tester is built in a 4 x 5 x 6 inch metal box.

By **H. R. WALTER**

Construction details on tape recorder flutter tester that can be made from commercially available parts.

ELECTRONIC service technicians, serious-minded audiophiles, and hi-fi hobbyists are always faced with the problem of tape recorder flutter and are concerned with the best possible mechanical adjustments to keep flutter to a minimum. Flutter is caused by variations in tape speed as the tape passes over the recorder heads and although it may be understood that minimum flutter results when optimum mechanical adjustments are made in the tape transport mechanism, together with replacement of worn parts such as drive wheels, belts, capstans, pressure rollers, etc., the question often arises, how can one know when optimum conditions have been attained?

Tape speed variations, or flutter, are particularly noticeable when a sine-wave signal or sustained notes from a musical instrument, such as the violin, are reproduced from the magnetic tape. Listening tests may result in reduction of flutter as various mechanical adjustments are made, but this method does not provide assurance that speed variations have actually been minimized.

The author has worked with laboratory-type flutter indicators which indicate the per-cent flutter of a mechanical system when used to reproduce a sine-wave signal. Since these instruments provide a high degree of accuracy, they are quite costly and are, therefore, usually found only in laboratories engaged in audio work.

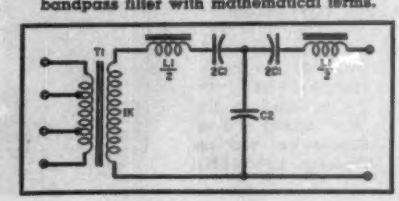
The author has often wondered if a practical instrument, using readily available parts at reasonable cost, could be constructed to enable the audio worker to check the results of mechanical adjustments and provide visual indication of his efforts.

Principles of Operation

A flutter indicator will measure variations in a sine-wave signal frequency, reproduced from a tape transport mechanism, due to speed variations of the magnetic tape.

The input circuit consists of an impedance matching transformer which may work into a bandpass filter network. The primary winding of the transformer may be tapped for common impedances, such as 4-, 6-, 8-, 16- and 600 ohms. The bandpass filter is designed for the flutter indicator fundamental frequency and attenuates hum and noise components in the recorder and amplifier system outside of the passband.

Fig. 1. Diagram of 3-element "T"-section bandpass filter with mathematical terms.



A special form of general purpose, or Wheatstone, bridge is connected to the output of the bandpass filter. This is known as a resonance bridge and is composed of three resistive arms and one series-resonant arm. By manipulating a capacitance-balance and a resistance-balance control the bridge can be balanced at the fundamental frequency and usually about 2% either side of this frequency, that is, minimum indication will be obtained on the null detector since at resonance the inductive and capacitive reactances are equal and, therefore, cancel out, leaving only a resistive component in this series-resonant arm.

With variations in tape speed, the fundamental frequency recorded on the tape will also vary and these deviations from the fundamental will result in a reactive component in the series-resonant arm. Under this condition the bridge, of course, will be unbalanced and the null detector will indicate some value above the minimum reading. Since the bridge becomes unbalanced when the tape test-signal frequency varies with tape speed, the null indicator will furnish information concerning the tape speed variation, or flutter. The null indicator, or meter, may be calibrated in per-cent flutter which is pro-

portional to the frequency deviations.

The flutter tester to be described was built to make comparative flutter tests and so was not calibrated. However, some calibration procedures are suggested later in the article.

Circuit Analysis

The input and bandpass filter circuit is shown in Fig. 1. The input transformer, T_1, is a line-to-speaker-voice-coil type and may have a tapped low-impedance winding or a single impedance for the input. This transformer works into the three-element "T" section bandpass filter which was designed for a frequency of 3500 cycles. Mathematical equations used in the filter design are given later for the benefit of the reader interested in constructing a filter with different operating characteristics.

The design frequency of 3500 cycles and impedance of 1000 ohms were used because it made possible the use of a transformer, inductors, and capacitors that happened to be available. Any design frequency may be chosen, but it would seem desirable to work between about 1000 and 4000 cycles. Low frequencies result in large inductors and capacitors. Higher frequencies bring on loss and intercoupling problems and more critical parts placement.

The bridge circuit, as mentioned previously, is a modified form of the Wheatstone bridge, known as a resonance bridge. In this bridge configuration, three of the arms contain only resistive components and one arm includes both inductive and capacitive reactances. See Fig. 2. The bridge is balanced by manipulating potentiometer R_4 and variable capacitor C. The reactance arm is adjusted by the capacitor to obtain a series-resonant condition, causing cancellation of the reactive components, resulting in only a resistance impedance at the audio signal frequency. If the input frequency to the bridge increases or decreases from the fundamental frequency, this will exhibit a reactive component and an a.c. vacuum-tube voltmeter or other null detector placed across the null indicator terminals will give a reading above the balanced condition, depending on the amount of frequency deviation. The null detector may be a v.t.v.m., oscilloscope, or headphones, but for this purpose an a.c. voltmeter is most suitable.

As in the case of the bandpass filter, mathematical treatment for the bridge circuit is given later for the reader wishing to design his own circuit. The complete schematic diagram of the flutter tester with parts values is shown in Fig. 3.

Any physical arrangement of parts will be satisfactory but there are several necessary precautions. The inductors should be of the shielded type. They should not be mounted too close to each other in order to avoid coupling effects. High *"Q"* inductors are desirable and for best results this is especially important in selecting the bridge circuit inductor.

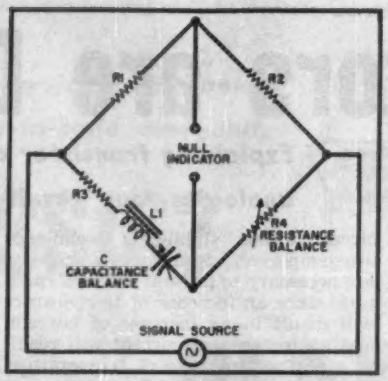


Fig. 2. Modified Wheatstone bridge circuit.

The desired bandpass for the filter network, as designed from the mathematical formulas, was obtained when the response was measured with resistive terminations. The band shifted slightly when the filter was connected in the complete circuit of Fig. 3. These filters should operate with resistive terminations with no, or very little, reactive components. Transformer reactance could possibly be cancelled out, but by experimentally altering the series capacitors in the network slightly, correction can be obtained.

This flutter tester was built for a service technician for making comparative flutter checks, to provide information concerning mechanical adjustments, and to indicate when the best possible adjustment has been affected. For this purpose the following procedure is recommended.

Feed a 3500-cycle signal from an audio oscillator to the input of the tester. Extreme accuracy of the oscillator frequency is not required since the bridge circuit covers the range from 3400 to 3600 cycles. Connect an a.c. vacuum-tube voltmeter across the null detector terminals. The oscillator output control and input control of the flutter tester should be set for a suitable reading on the meter. Adjust the balance controls on the tester to obtain a minimum reading on the meter. The sensitivity of the voltmeter should be increased by means of its range switch, as required, to obtain the minimum indication. Make a note of this reading. Measure and note the audio voltage input to the tester. The same voltmeter may, of course, be used for this purpose. Now, feed the oscillator to the tape recorder and record this same signal frequency on a tape in the normal manner. This tape is then played back through the recorder and the output fed to the input of the flutter tester. The input impedance of the tester should be selected to be close to the output impedance of the recorder. Adjust the signal level by means of the volume control on the recorder to obtain the same voltage level to the tester that was noted when the oscillator was fed to its input. Observe the reading of the voltmeter connected across the null detector terminals. After making mechanical adjustments or replacing worn parts on the tape transport mechanism, this same test tape is again played back to the flutter tester. The main purpose of the test is to obtain the lowest possible reading on the vacuum-tube voltmeter, or null detector, which corresponds to minimum flutter.

In making this comparative test, it should be noted that the balance controls are adjusted only when originally feeding the oscillator directly to the flutter tester and are not to be changed when playing back the signal recorded on the tape to the tester. The foregoing procedure may at first sound involved, but actually it isn't once the operator runs through the test once or twice.

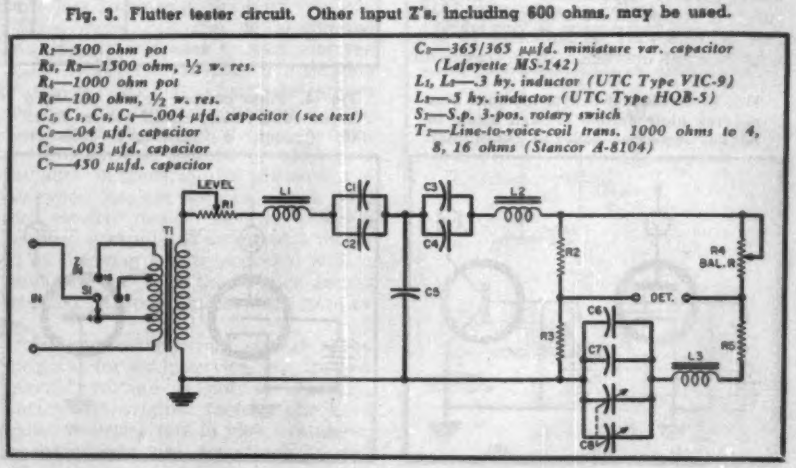
If the recorder level is not high enough, or the output impedance does not provide a suitable match, the recorder may be played through the regular audio system or through a utility amplifier. The unit shown, however, operated satisfactorily with as little as 0.2 volt to the input.

Other Procedures

Since the flutter tester was constructed for comparative flutter tests, it was not equipped with a self-contained null detection meter nor was it calibrated to indicate the magnitude

(*Continued on page* 106)

Fig. 3. Flutter tester circuit. Other input Z's, including 600 ohms, may be used.



Transistors are Different

By **ED BUKSTEIN**
Northwestern Television & Electronics Institute

Explaining transistor operation with vacuum-tube analogies may result in several misconceptions.

BECAUSE learning is a process of viewing the unfamiliar in terms of the familiar, it is natural to attempt to study transistors by comparing them to vacuum tubes and noting the similarities. Although some such similarities exist, the transistor differs from the vacuum tube in more respects than it resembles it. For this reason, it is more fruitful to consider the differences rather than the similarities:

1. The relationship between bias and output current in a transistor is opposite that of a vacuum tube. In the vacuum tube, bias is a *voltage* applied between grid and cathode. Increasing the value of bias will result in a *decrease* of plate current. This is shown in Fig. 1A, where closing the switch would cause the meter pointer to swing down in the direction of the broken arrow. In a transistor, bias is a *current* which flows through the emitter-base circuit. Increasing the value of bias will result in an *increase* of collector current, as in Fig. 1B.

2. Cut-off in a transistor is a condition of minimum, but not zero, collector current. When a vacuum tube is cut off (by increasing the bias sufficiently), the plate current is zero. (Fig. 4A.) When a transistor is cut off (by removing the bias), a small amount of current still flows in the collector circuit. (Fig. 4B.) The collector current which continues to flow when the emitter current is zero is known as the cut-off current, or I_{co}.

3. The transistor is a temperature-sensitive device. Within a wide range of temperatures, the performance of a vacuum tube remains relatively unaffected. A radio receiver employing vacuum tubes may work as well outdoors during an Alaskan winter as it does on a hot beach in July. The operation of a transistor, however, shows a much greater dependence on temperature. A temperature change of only a few degrees may be sufficient to prevent normal operation of a transistor circuit unless stabilizing techniques are employed. Stabilization circuits are necessary to prevent thermal *runaway*, since an increase of temperature will result in an increase of current, and an increase of current will result in a further increase of temperature, *ad infinitum*. See Fig. 5.

4. Incorrect polarity of collector voltage will damage the transistor. If the "B" supply of a vacuum tube is accidentally reversed, the circuit will be inoperative but the tube will not ordinarily be damaged. (Fig. 2A.) By contrast, the transistor will be ruined if voltage of improper polarity is applied to the collector. (Fig. 2B.) Under these conditions, the collector junction will be biased in the forward direction, excessive current will flow, and the junction will overheat. For proper operation of an *n-p-n* transistor, the collector should be operated at a positive potential. The *p-n-p* transistor requires a negative collector voltage.

5. The input impedance of a transistor is relatively low. The input impedance of a vacuum tube is high, particularly in circuits which do not draw grid current. For this reason, vacuum-tube circuits may be cascaded without introducing excessive loading of the preceding stage. This is shown in Fig. 3A, where the connection of the second vacuum tube drains off very little current from the first stage. Cascading of transistor stages, however, presents a greater problem because the low input impedance of each stage tends to load the output circuit of the preceding stage, as in Fig. 3B. Adding the second transistor stage causes some current to flow from the first stage. Such loading has an adverse influence on gain and frequency response. The exact numerical value of input impedance depends upon the type of transistor, parts values, and the type of circuit connection. Grounded-collector stages have higher values of input impedance than grounded-emitter or grounded-base stages, but the voltage gain of the grounded-collector circuit is less than one. Another consequence of the low input impedance of the transistor is that large values of coupling capacitance must be used to maintain adequate low-frequency response. Coupling capacitors from 2 to 50 μfd. are not rare in transistor audio stages. —30—

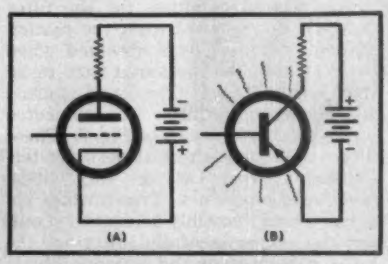
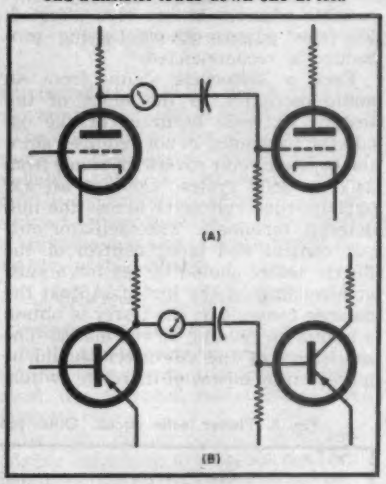


Fig. 2. If applied voltage polarity is wrong, a tube (A) will not function but a transistor (B) will be ruined.

Fig. 3. (A) Tube at right drains little current from preceding stage. (B) Second transistor loads down one at left.



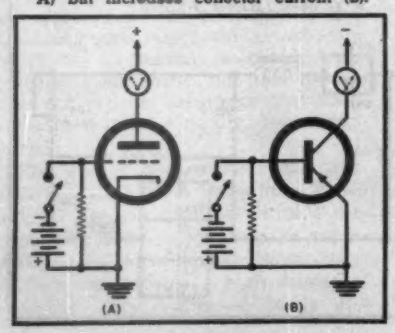


Fig. 1. Closing switch to increase bias reduces plate current (broken arrow in A) but increases collector current (B).

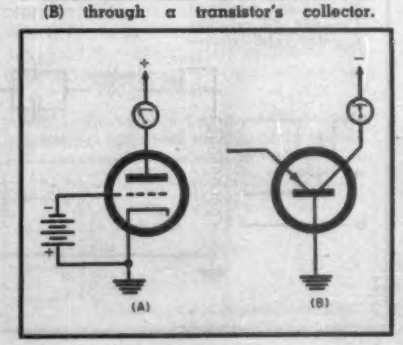


Fig. 4. Plate current is zero (A) in a cut-off tube. Some cut-off current flows (B) through a transistor's collector.

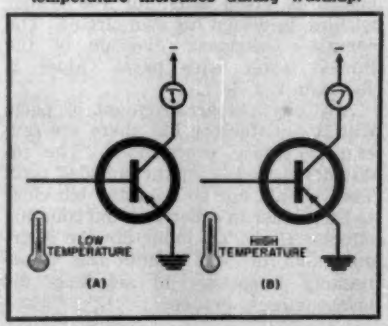


Fig. 5. The collector current of a transistor increases (see ammeters) as its temperature increases during warmup.

Any transformerless set you service gets a quick safety check with this easy-to-build test unit.

HOT CHASSIS? PLAY IT SAFE

By **KENNETH BRAMHAM**

EDITOR'S NOTE: *Working on a chassis that is not isolated from the supply line is an old story for experienced technicians. However the lay owner of such a set, less well informed, may unwittingly place himself in danger. Service people concerned with this problem will welcome the improvement in the safety factor made possible by the author's technique. Publicizing such a safety check is a good selling point with customers.*

A RADIO OR TV chassis that is connected directly to the power line is nothing new to service technicians. Before the advent of transformerless TV receivers, there were the common a.c.-d.c. radios. Servicing such equipment has always called for some caution to protect personnel and test equipment. An occasional shock or blown fuse is nothing new. However, what is an inconvenience to the technician may become a hazard for the set owner.

Aggravating this problem is the use of metal cabinets in so many of today's transformerless receivers. If the chassis becomes shorted to such a cabinet, the shock hazard is obvious. However, the full extent of this hazard is often overlooked. A live cabinet is often the potential source of a *220-volt* shock. That's right—not 110 volts, but 220.

The electrical system of an increasing number of homes on this continent consists of a three-wire system, as shown in Fig. 1. This is not confined to homes in which 220-volt wiring is specifically available for electric ranges, dryers, air conditioners, and the like. Even where all available outlets provide 110 volts, they may be arranged in two lines in the configuration shown. Only 110 volts may be present between the hot side of outlet *A* and ground, or outlet *B* and ground, but the full 220 volts can be measured between the hot side of outlets *A* and *B*.

Take the case of a TV receiver plugged into outlet *A* with a chassis-to-cabinet short. Near the set may be a defective lamp plugged into outlet *B*. An unsuspecting citizen reaches for the light while manipulating his TV set . . . if 110 volts can be lethal, 220 is considerably more dangerous. This, of course, is just one of many possibilities. Why take a chance on losing a customer the hard way?

Complicating the problem is the fact that most metal-cabinet, live-chassis TV receivers have a resistor between chassis and cabinet to prevent the development of a potential between these two elements. Usually on the order of a quarter megohm, this resistor is shown as 270,000 ohms in the specific circuit of Fig. 2A. Even under near-perfect conditions with this resistor in the circuit, a slight shock may sometimes be felt. This source of complaint can easily be remedied by reversing the polarity of the line plug in its socket. Unfortunately, the set owner is seldom in a position to judge whether a slight shock received is a normal one that can be handled in this way or whether there is an actual defect that requires attention.

A vexing problem based on this set-owner experience often occurs shortly after a transformerless receiver has been serviced and returned to its owner. If the owner has managed to get the plug into the outlet the wrong way, a call to the service company will doubtless result. If the service dealer cannot be reasonably sure that the only cause is a reversed plug, an additional service call, usually charged to "customer relations," is often necessary just to reverse the plug.

This extra call can be eliminated and the customer can be told over the phone to reverse the plug if a reliable system of testing for chassis-to-cabinet shorts is adopted at the time of service. Aside from the specific case just described, such a system of testing is valuable in general. It protects the customer against serious shock and the service dealer against possible liability. A rapid and dependable method of checking can be provided with a simple device that the service establishment can put together for its own use.

The ohmmeter would appear to be adequate for such service, but its low internal voltage is not satisfactory. During the original factory check of transformerless sets in metal cabinets, manufacturers use something in the range between 700 and 1100 volts. In this way, marginally defective capacitors or other components that would be missed in a low-voltage test are shown up.

The checker whose schematic is shown in Fig. 3 can be built up for less than $10—still less if "junk-box" parts are used—and housed in the plastic cabinet of a discarded portable radio or a small utility cabinet. Power transformer *T*, may be a TV type unit providing 700 volts or more across its secondary. An old one that has been discarded because one of its filament

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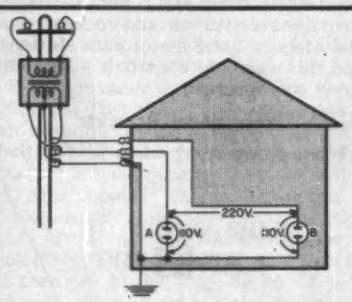
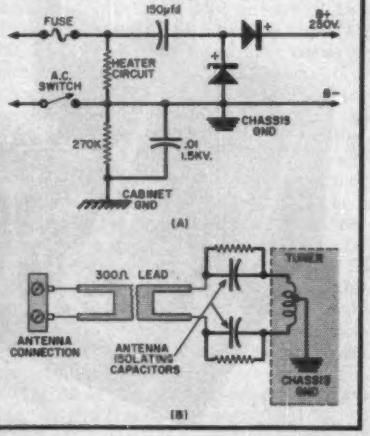


Fig. 1. A 220-volt shock is possible from normally wired 110-volt outlets.

Fig. 2. Breakdown of .01-μfd. unit in (A) or isolating capacitors in (B) may render cabinet or exposed parts "hot."



Advanced Ham Receiver in Kit Form

RADIO & TV NEWS LAB TESTED

Double-conversion 15-tube amateur-only receiver with selectable sideband has excellent performance.

EVER since the emergence of the kit, we have felt that it would be just about impossible to design, for the home constructor, a truly "professional" ham communications receiver in kit form. We believed that the problems would be too many and the complexity would be too great. But the *Heath Co.* has gone right ahead and done it with its new "Mohawk" receiver. Admittedly, this kit is by far the most expensive and most elaborate receiver in the firm's line. It costs about $275 and comes in three large cartons weighing a total of 90 pounds. When the heaviest carton, which has all the components in it, is unpacked, even the experienced constructor is apt to be taken aback. There are almost enough parts in it to go into competition with your local parts dealer. We must say, though, that after 38 hours of mounting and wiring and another 7 hours of checking parts, double-checking the wiring, and (after a brief listening tryout) complete alignment, it was well worth all the time and effort. It was certainly a thrill, after stringing 2 dial cords, plugging in 3 crystals, and inserting 15 tubes and 5 pilot lights, to turn the receiver on and to hear, immediately, a good many ham stations. And this was before a single alignment screw was touched!

"Professional Receiver"

What do we mean when we say that an amateur receiver is "professional?" First, it compares favorably with already assembled units costing about $400. Second, it has the special features required for advanced ham use. It must be emphasized that this is not a general-coverage receiver, but that it tunes only the strictly ham frequencies from the 160-meter band up to the 10-meter band, spreading each ham band out along the 10-inch dial.

Basically, the set is a 15-tube, double-conversion superhet with selectable sideband. The first intermediate frequency is 1682 kc. while the second intermediate frequency is 50 kc. Variable selectivity, from 5 kc. down to 500 cps, is provided along with a 50 db rejection notch from a bridged-T notch filter for heterodyne rejection. The signal-to-noise ratio is given by the manufacturer as 10 db at less than 1 μv. input. Output power is 2 watts into an 8-ohm speaker or a 500-ohm line or phones. Neither the speaker nor the phones is supplied with the kit. For stability the high-frequency oscillator is voltage regulated and cathode-follower isolated. Crystal oscillators are used for the lower frequency i.f. Still another crystal oscillator is used as a 100 kc. calibrator in order to obtain exact dial readings. Low-noise tubes are used where required.

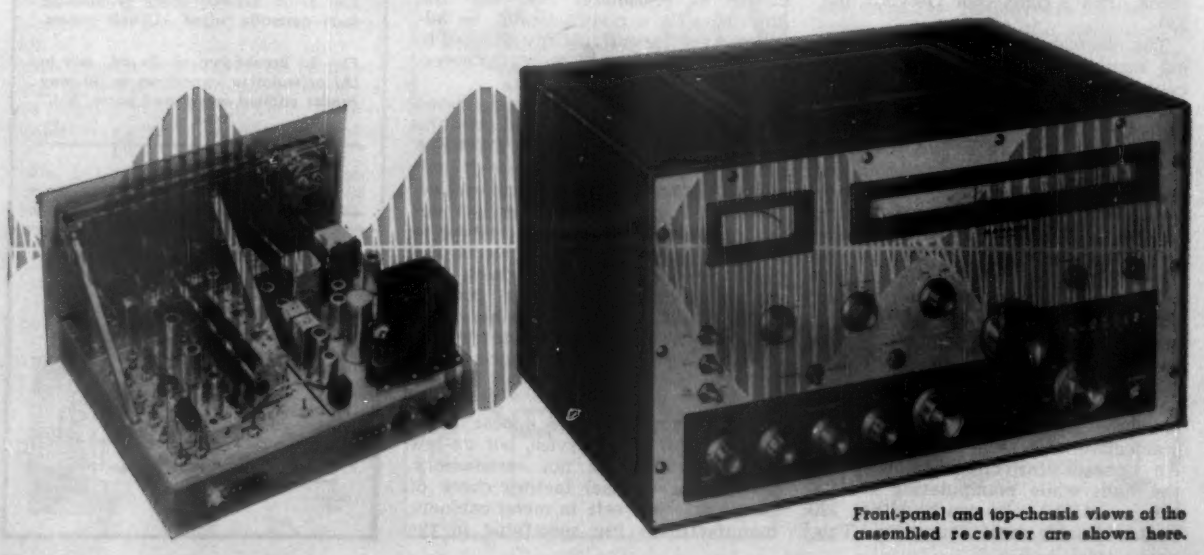
The front end, comprising the r.f. amplifier, first mixer, and first oscillator, is completely prewired and aligned. This eliminates what would have been a fairly difficult construction and adjustment procedure.

Construction

Since the receiver was designed for the advanced ham who has had quite a bit of experience building more complex gear, one might think that assembling this kit is a difficult job. Elaborate and time-consuming it is, but difficult it is not. This is due to the straightforward design and the complete 70-page instruction manual which comes with the kit. True, there were some discrepancies in the first printing of the manual, the one we used. These have been reported to the manufacturer and we feel sure that corrections will be made before any more manuals go out.

To simplify construction, the small 3-tube 1682 kc. i.f. subchassis is wired first. (See bottom view.) Then, the 5-wafer selectivity switch is wired. Next, the large 50 kc. i.f. and audio subchassis is put together and mounted in place on the main frame. Then, the dial mechanism is assembled and installed. This is followed by mounting of the small i.f. subchassis and the prewired front end. Front panel controls are mounted and wired in, and you're in business.

All the wiring is strictly point-to-point and no printed circuits are used. There is one pre-assembled laced wir-



Front-panel and top-chassis views of the assembled receiver are shown here.

ing harness employed. This tremendously simplifies interconnections between the 50-kc. chassis and components on the front and rear panels. Even the entire dial assembly, along with its several gears, pulleys, and two dial cords must be built from scratch. (One of these cords moves the dial pointer while the other rotates the entire dial drum when the frequency band is changed.) Although there are a good many individual parts that go into this assembly, the final operation is quite smooth except for a slight amount of backlash in the main tuning. This was caused by some movement on its shaft of the nylon gear used in the gear train drive.

A most useful special tool, supplied with the kit, was a little red plastic nut starter used to hold small nuts and get them started on their matching screws. Particularly helpful in locations not too easily reached with the fingers, this little tool saved plenty of time in the mounting of parts and in the mechanical assembly.

During the final stages of the assembly a short prefabricated coax cable with phono-plug fittings on it is used to interconnect the front end output to the 1682 kc. i.f. chassis input. In the kit assembled, this lead was just a bit too short. If the cable is "stretched" to make it fit, the strain on one of the end fittings could result in a "B+" short to ground at the phono jack. This would not only remove signal but would also overheat the decoupling resistors in the 1682 kc. i.f. chassis before the fuse has a chance to go. To prevent this, we filed a slot in the mounting bracket around which the cable had to be stretched. This lead certainly should be supplied a little longer so that the filing would not be necessary.

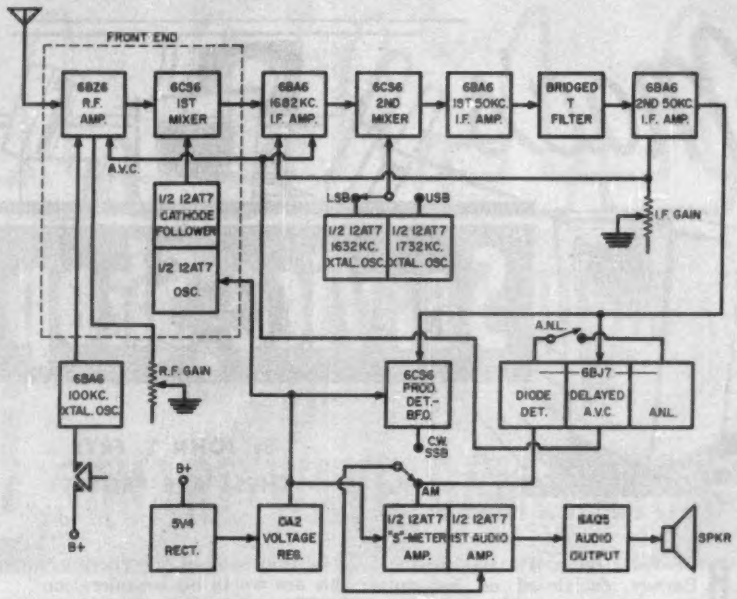


Fig. 1. Complete block diagram of the ham communications receiver is shown here.

Circuit

The block diagram (Fig. 1) shows the circuit. The antenna is coupled to a 6BZ6 r.f. amplifier. This stage has a separate manual gain control to prevent overloading. Delayed a.v.c. is also used here. High-*"Q"* coils on ceramic forms keep losses down and improve stability. A front panel antenna trimmer peaks up the input circuit for various antennas. The amplified r.f. is then applied to a 6CS6 first mixer, a dual-control pentagrid type which was chosen for its high gain and low noise. Also feeding the mixer through a cathode-follower is the output of the first conversion oscillator. A 12AT7 twin triode is used here for both these functions. A front panel oscillator trimmer fine-tunes this circuit for exact dial reading as marked by the 100 kc. crystal oscillator. High-*"Q"* circuits are also used for the mixer and oscillator. The mixer output is connected through a short length of coax to the 1682 kc. i.f. subchassis.

The 1682 kc. amplifier is a transformer-coupled 6BA6 which is a.v.c.-controlled. Front panel control of bias is used for manual i.f. gain control. The use of this high i.f. virtually eliminates any image response. The signal is then transformer-coupled to a 6CS6 second mixer. Also applied to this stage is the output of either one of two crystal oscillators (12AT7 tube). One of these operates 50 kc. below 1682 kc. while the other operates 50 kc. above 1682 kc. This allows either sideband of an incoming signal to the placed within the bandpass of the receiver. The feature is used mainly in the reception of SSB signals. The mixer output is 50 kc., which is the second i.f. By using this low frequency a high degree of selectivity is obtained. The second i.f. is then fed to the large 50 kc. i.f. subchassis, which also has the audio and power circuits on it.

Next in line is a two-stage 50 kc. i.f. amplifier using 6BA6 tubes. Since selectivity is more important than gain here, the first 6BA6 is triode-connected. Both input and output of this amplifier are made up of two high-*"Q"* 50 kc. i.f. coils that are capacity coupled and resistance loaded. A front-panel selectivity switch varies the coupling and the loading to change the over-all selectivity of this amplifier. The cathode of the second 6BA6 is connected to the manual i.f. gain control. Between the two i.f. amplifiers is a bridged-T notch filter to reject unwanted signals. Sharply tuned *LC* components are used to produce a 50 db rejection notch. The position of this notch is adjustable from the operating panel. The notch circuit may be shorted out when it is not needed to reject an interfering signal.

The 50 kc. output is then applied to a

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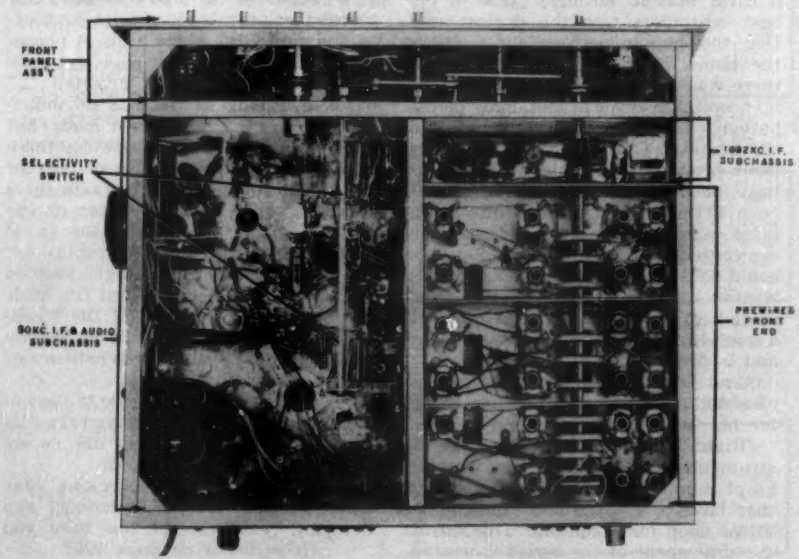
Under-chassis view of the receiver with major assemblies labeled. Refer to text.



Mac's Service Shop

By JOHN T. FRYE

THESE ARE PROBES?

"BR-R-R-R! Baby, it's cold outside!" Barney exclaimed as he came stomping into the front room of the service shop and laid a chilly hand against the back of Miss Perkins' neck. The office girl let out a shriek and grabbed up a paperweight with which to defend herself against the grinning youth whose blue eyes twinkled down at her as he brushed away the huge snowflakes clinging to his coppery red hair. Suddenly his face took on a look of mock fright, and holding his arm crooked defensively in front of his face, he went through the service department door at a stumbling run.

"Whew! That Matilda's temper gets worse every day," he announced to his employer, Mac, who was sitting at the bench examining a group of odd-looking, black, cylindrical objects spread out in front of him. "Hey, what you got there; something new?"

"Yep. These are new probes put out by the *Doss Electronic Research* people and Jim, the salesman, left them here. He wants me to play around with them a little and tell him what I think of them."

"I imagined the probe field had been pretty well developed."

"Well, several of these gadgets stretch the word 'probe' pretty far. Actually they are specialized service instruments in compact, portable form."

"That ought to make them pretty useful on house calls."

"I was thinking along the same line. As you know, several times each day the technician has to make an important decision: can a set be properly repaired in the home or should it be taken to the shop? To make the decision intelligently, he must know the nature and extent of the repairs needed. What's more, if the set has to go to the shop, the customer is very likely going to want an estimate of the cost in advance. That means the technician must be able to localize the trouble right on the spot and make a good guess as to what will be needed to correct it. All this means that any instruments that he can easily take with him that will aid in cornering the trouble are worth his consideration."

"You prefer to repair the set in the home if at all possible, don't you?"

"It's not a matter of preference; it's nearly a matter of necessity. We both know that it is a lot more convenient for the technician to work at the service bench where all the tools and instruments he needs are right at his fingertips, where the light is good, and where he can work in familiar, comfortable, distraction-free surroundings. Since the set can be checked thoroughly and test-run for an adequate length of time, the chance of a callback is lessened. On the other hand, the customer understandably prefers home repairs because the set will be out of use a minimum amount of time; the charge will be for only one trip to the house; and he can see—or so he fondly, but mistakenly, believes—if he is getting his money's worth.

"The whole situation reminds me of when I was a boy in a backwoods section of Arkansas and my dad operated a rural taxicab business. One of his best customers was the doctor; and Doc, too, had to perform his work in the home, if at all possible, because there was no hospital close; there was no hospital insurance; and many of the patients had a mortal fear of going to the hospital. As a result, Doc really went prepared. I'll never forget that huge black bag he lugged around. It bore little resemblance to the sleek little bags doctors carry today. With the contents of his bulging satchel Doc could deliver a baby, treat a snakebite, remove an appendix, or rout a deep-seated case of malaria. That bag was a miniature pharmacy, operating room, and laboratory, all rolled into one."

"And you think the service technician today needs similar furnishings for his tool chest."

"Right. Unless he has the proper instruments with him, he can waste a lot of time trying to locate trouble and then have to give up and take the set to the shop for diagnosis. This means the time spent at the house is wasted. Any attempt to estimate the cost of repairing the set can be nothing more than a wild guess."

"Do you think these probes will help?"

"We won't know until we try them, but some look promising. Take this one, called 'Electrolytic Substitute,' for example. It's a streamlined version of an old dodge we've used for years. You know how a good filter unit bridged across an open one will often produce a surge of current that temporarily heals the defective electrolytic so you're not sure if it was bad or not. We got around this by 'easing' the new capacitor into the circuit with a series variable resistance that was gradually reduced to zero value.

"*Doss* does it a little differently. They use a fixed resistor that can be switched in series with either of two values of capacity inside the probe. One value is for use in bridging capacitors in the 10-40 μfd. range; the other for bridging larger capacitors. The probe capacitor charges slowly through this resistance until a neon lamp in the probe lights up to indicate it is fully charged. Then a switch is thrown to cut out the series resistor. This switch permits the probe capacity to be cut in and out of the circuit at will, maintaining the capacitor fully charged all the while, without causing any circuit-disturbing surge of current."

"That ought to be real George for checking the electrolytics in a hurry. How about this thing that's called a 'Sweep Analyzer'?"

"You'd never guess from the name, but that probe is for checking any sort of transformer or yoke winding for shorted turns or shorts to the core or between windings."

"How does it work?"

"You use it with a scope. The three leads coming out of the shielded cable go to the vertical and horizontal input terminals, like so. Now we plug the a.c. cord into a socket and flip this little switch on the side of the probe. This connects a charged capacitor across these two leads not yet connected and across the scope leads. A phase-shifting network in the leads going to the scope produces that inverted "L" pattern as long as there is no inductance connected to the test leads, but when an inductance is between these two leads, the sharp pulse of current and the bridging capacitor sets up a damped oscillation that is seen on the scope as a spiral. Usually the spiral will have several complete revolutions, but the presence of a single shorted turn in the winding between the leads or in any other winding of the transformer will load the circuit so heavily that a complete revolution will never be made."

"I suppose you would have to disconnect any heavy loads, such as tube filaments, speaker voice coils, and so on, when making the test?"

"That's right, and in checking yoke windings, you have to disconnect any damping resistors. In this case you

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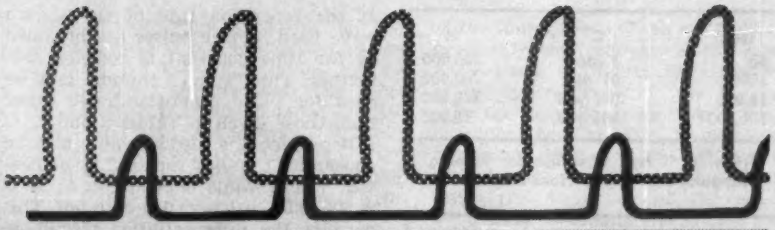
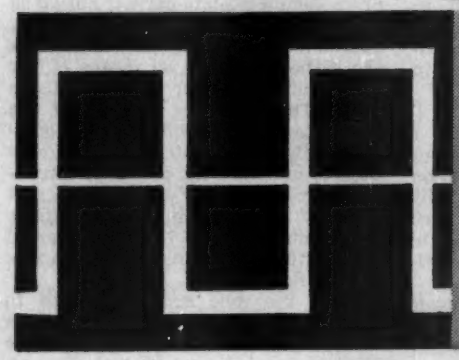
By LOUIS E. GARNER, JR.





SPECIAL APPLICATIONS OF THE SQUARE-WAVE GENERATOR

Form your own saw-tooth waveforms, peaked pulses, triangular waves, and high-frequency sine waves. Also use for blanking, marking, and counting.

THE USE OF a square-wave generator for testing amplifier circuits has been described frequently. The applications of this device are not limited to amplifier testing, however. Like many other pieces of electronic equipment, its applications are almost unlimited, the governing factor being the ingenuity and skill of the user. With but few accessories, the square-wave generator may be used as a bi-directional pulse generator, uni-directional pulse generator, triangular wave generator, sine-wave generator, or linear saw-tooth signal generator. It may be used for checking the frequency of a tuned circuit and for determining the frequency of an unknown signal. It is also valuable as a blanking-signal source and marker generator.

In every case, the accessory circuits required can be assembled from stock-value parts by any competent technician. Except in the case of those few circuits requiring tubes, assembly time should be a matter of minutes.

No effort will be made here to expand upon the uses of the various signals that may be obtained from the square-wave generator, nor to give more than two or three examples of its use for frequency measuring, blanking, and as a marker. Instead, the development of the special output pulses themselves will be discussed.

Bi-directional Pulses

Probably the easiest special signal to obtain from a square-wave generator (other than a square wave!) is a bi-directional pulse. All that is necessary is a resistor and capacitor connected in series to form a simple differentiation circuit (Fig. 1A). The square-wave generator is connected across the *RC* combination and the bi-directional pulse obtained across the resistor.

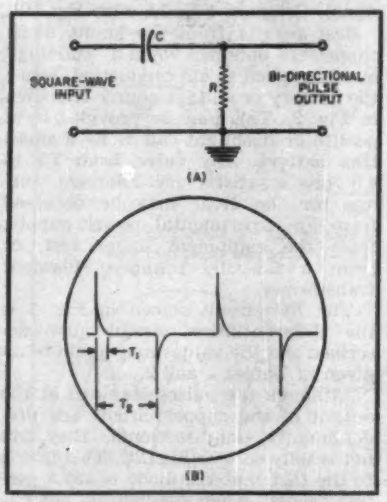


Fig. 1. Simple network (A) for forming peaked bi-directional pulses (B).

f (pps)	C	R
50	.05 μfd.	1000
1000	.005 μfd.	1000
10,000	.0005 μfd.	1000
100,000	50 μμfd.	1000

Table 1. Values for producing sharply peaked pulses with circuit of Fig. 1.

Table 2. Values for greater pulse width than provided by constants of Table 1.

f (pps)	C	R
50	.1 μfd.	1000
1000	.01 μfd.	1000
10,000	.001 μfd.	1000
100,000	100 μfd.	1000

The amplitude of the pulse will approach the amplitude of the applied square-wave signal provided capacitive loading across the resistor is kept to a minimum and provided the applied square wave has a short rise time. Pulse width will depend on the *RC* time constant, as will the decay time of the pulse signal.

In Tables 1 and 2 are given *RC* values for a differentiation circuit permitting narrow pulses at the repetition rates (*f*) shown. The value of *R* has purposely been kept constant at 1000 ohms to minimize any loading by the circuit in which the pulses are to be used. The values given for *C* are indicated rather than actual (variation depending on parts tolerances) and were determined empirically.

Referring to Fig. 1B, the ratio of pulse duration time (T_1) to time between pulses (T_2) has been used as an indication of pulse width. Table 1 gives the values used for $T_1 = .05T_2$, while Table 2 gives the values used for $T_1 = .1T_2$.

For good pulse formation, the time constant of the *RC* circuit (time constant = *RC*, with *R* in megohms, *C* in microfarads, *T* in seconds) should be less than .01 of the time for one cycle

f (pps)	C	R
50	.1 μfd.	200,000
1000	.01 μfd.	100,000
10,000	.001 μfd.	100,000
100,000	.001 μfd.	10,000

Table 3. R and C values for forming triangular waves at various frequencies.

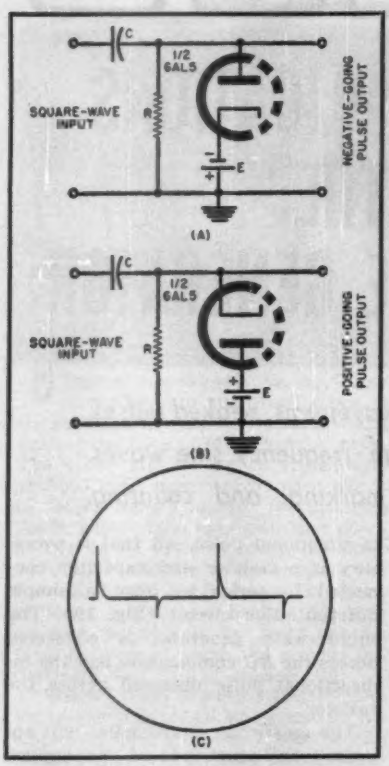
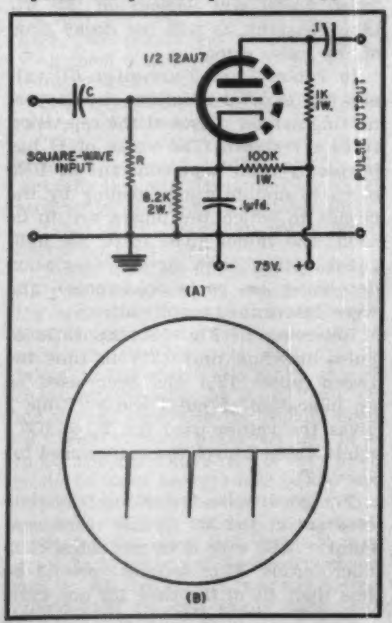


Fig. 2. Diodes yield basically uni-directional pulses, positive or negative.

Fig. 3. True uni-directional output pulses are yielded by a triode clipper.



at the repetition rate of the square wave used. Better pulses are obtained as the time constant is reduced still further. This "rule of thumb" may be used for pulse repetition rates other than those given in Tables 1 and 2.

If preferred, a median value may be chosen for *C* and *R* replaced by a rheostat whose value depends on *C*. If *C* is 500 μμfd., use a 25,000-ohm pot. This permits the differentiation circuit to be wired as a permanent accessory. *R* is then adjusted for the pulse width desired at the repetition rate used in different applications.

Uni-directional Pulses

Often a bi-directional pulse will not be suitable in the desired application and a pulse that is partially or wholly uni-directional is required. In such cases, it is a fairly simple matter to add a clipper circuit to the differentiation circuit just described.

The simplest clipper is a shunt diode (Fig. 2). The diode acts to "short" the applied signal when conducting and thus permits pulses that are predominantly uni-directional to be obtained. Whether positive- or negative-going pulses are obtained depends on how the diode is connected, that is, whether conduction occurs on the positive or negative "half" of the applied signal. Compare Fig. 2A with Fig. 2B.

Best results from the shunt diode clipper are obtained when a "starting" bias is applied to aid conduction, hence the battery or voltage source *E* shown in Fig. 2. This may be provided by a penlite or flashlight cell or by a small bias battery. Any value from 1.5 to 4.5 volts is satisfactory. Filament voltage for the diode may be obtained from an experimental power supply, from the equipment under test, or from a 6.3-volt, 1-ampere filament transformer.

The *RC* circuit shown in Fig. 2 is the differentiation circuit just described and the values may again be as given in Tables 1 and 2.

Although the pulses obtained at the output of the clipper circuit are predominantly uni-directional, they are not wholly so. See Fig. 2C. This is due to the fact that the diode is not a perfect "short" when conducting, but has a certain amount of internal resistance which permits a small pulse of the opposite polarity to appear. With *E* equal to 3 volts and the *RC* values given in Table 1 for a repetition rate of 1000 cps, it was found that the desired pulse amplitude had a relative height of 10 compared to 4 for the undesired pulse of opposite polarity. However, for many applications this differential in pulse amplitudes is satisfactory.

For those special applications requiring a true uni-directional pulse, a biased triode clipper may be used in place of the shunt diode. A satisfactory circuit is shown in Fig. 3A. This circuit, as well as the other circuits requiring a tube, may be built on a small chassis and used as a permanent accessory. Power may be obtained from the square-wave generator's power supply, from the equipment under test, or from a small experimental power supply. *R* and *C* values in the differentiation circuit are as before. The values of other components are given directly on the diagram.

In operation, the triode is biased heavily by the large cathode resistor. Since complete plate-current cut-off is not obtained by cathode bias alone, additional current is drawn through the cathode resistor by means of the 100,000-ohm bleeder connected to "B+." This increases the bias of the triode past the cut-off value. A comparatively small plate-load resistor is used to minimize the effects of distributed wiring capacity and tube internal capacity. This permits the waveshape of the output pulse to be maintained even with narrow pulses and high repetition rates.

With the tube normally biased to cut-off, no plate current flows except when the grid is driven in a positive direction past the cut-off bias. This occurs only on the positive-going pulses of the signal appearing across *R*. Hence the output pulses are completely uni-directional. The phase inversion of the single stage results in negative-going output pulses, as shown in Fig. 3B.

If pulses of higher amplitude are desired, the clipper may be followed with one or more stages of resistance-coupled amplifiers. Conventional circuits may be used, but plate-load resistors should be kept low in value and distributed wiring capacity held to a minimum if good pulse waveshape is to be maintained. Use an even number of stages if negative-going pulses are desired for final output and an odd number of stages if positive-going pulses are wanted.

If the clipper is followed by a conventional phase-splitter stage, both positive-going and negative-going pulses may be obtained simultaneously or separately from cathode or plate. Selection of either may then be made by means of a s.p.d.t. switch.

Triangular Waves

A triangular wave is distinguished from a saw-tooth wave (which also has a waveform resembling a triangle) in that the positive and negative slopes are usually more equal. Generally, the expression "triangular wave" refers to a signal more properly called an "equilateral triangular wave" in which the slopes of the waveform are similar to the sides of an equilateral triangle, as in Fig. 4B.

Triangular waves are used in a number of special electronic applications and are often desirable in experimental work. They may be obtained from a square-wave generator by reversing the positions of *R* and *C* in the simple differentiation circuit previously described, thus forming an integration circuit, as shown in Fig. 4A.

In Table 3 are given values of *R* and

C for good triangular wave formation for different square-wave repetition rates. The values given may be considered the minimum necessary to form a triangular wave with reasonably straight sides and good amplitude. Increasing either *R* or *C* (or both) in any particular case will improve the waveform slightly, but at the expense of amplitude. However, with the values given, considerable expansion of the waveform horizontally and vertically (on the screen of a CRO) is necessary to distinguish any variation from a "straight-line" slope.

Unfortunately, the distributed wiring capacity and the impedance of the circuit connected across *C* may affect the waveshape if changes in the square-wave repetition rate are made without changing both *R* and *C*. Note that neither *R* nor *C* may be kept constant over the entire range of frequencies considered (Table 3). If *R* is increased to an extremely large value (*C* kept constant) for the lower frequencies, the sides of the triangular wave will become curved (Fig. 4C). Reducing *R* and increasing *C* will restore the waveshape even though the time constant of the *RC* circuit may stay the same.

Sine-wave Formation

Sine waves of very good shape can be obtained from a square-wave generator by connecting an *LC* tuned circuit across the output and obtaining the sine-wave signal from across either *L* or *C*, as shown in Fig. 5B. The sine wave obtained (Fig. 5A) will be almost "perfect" if the "*Q*" of the tuned circuit is reasonably high. Even with a comparatively low "*Q*," it is difficult to distinguish the signals obtained from a true sine wave upon casual observation.

It is mandatory, however, that the resonant frequency of the tuned circuit be reasonably close to the square-wave frequency (or repetition rate). The author used a choke rated at 1 henry and a paper tubular capacitor rated at .05 μfd. to form sine waves of approximately 1000 cps.

The frequency of the sine wave depends on the frequency of the tuned circuit, while the "quality" of the waveshape depends on the "*Q*" of the circuit and also on how closely the square-wave frequency approaches the tuned-circuit frequency. Because of this, the circuit connected across *C* (Fig. 5B) should not load the output appreciably. If desired, a single-stage, resistance-coupled amplifier may be used as a buffer between the output and load.

Frequency Measurement

If the *LC* combination shown in Fig. 5B represents a tuned circuit whose frequency is unknown, the square-wave generator may be used to determine the frequency of this circuit. To do this, connect a cathode-ray oscilloscope across *C*. Start with a low-frequency square wave and increase the frequency in steps until a waveform approaching that shown in Fig. 5C is obtained. The number of cycles of damped oscillation appearing on the square wave is not too important, as long as the individual cycles can be distinguished and counted. The relative amplitude of the damped oscillations and the "square-wave" portion of the signal will depend on the "*Q*" of the tuned circuit. A waveform like that shown in Fig. 5C is obtained with low-"*Q*" circuits.

If the circuit being checked has high "*Q*," the "square" portion of the wave may be lost entirely, making interpretation difficult. In such a case, a small resistor (100 to 1000 ohms) may be connected in series with *C* to lower the "*Q*" of the circuit without changing its resonant frequency.

To determine the frequency of the tuned circuit, count the number of "cycles" contained in the upper (or lower) portion of the square wave. In Fig. 5C, approximately five cycles would be present, even though the signal is damped out by the fourth cycle. Multiply this value by two to obtain the number of cycles that would occur during a complete cycle of the square wave. Then multiply this product by the frequency of the square wave itself to obtain the frequency of the tuned circuit.

In the example given, five cycles in the upper portion of the square wave represents ten cycles total. Hence, the frequency of the tuned circuit is ten times the frequency of the square wave used. Assuming the square wave to have a frequency of 100 pulses-per-second, the tuned circuit's frequency is 1000 cps.

Although this technique sounds time-consuming, in practice it is quite rapid, once learned. In many cases, the frequency of a tuned circuit (particularly one having low "*Q*") may be determined much more rapidly with this technique than by using a variable-frequency oscillator, a v.t.v.m. (or scope) and then adjusting for peak output.

Linear Saw-tooth

Extremely linear saw-tooth signals are often required for the horizontal sweep of an oscilloscope. While the

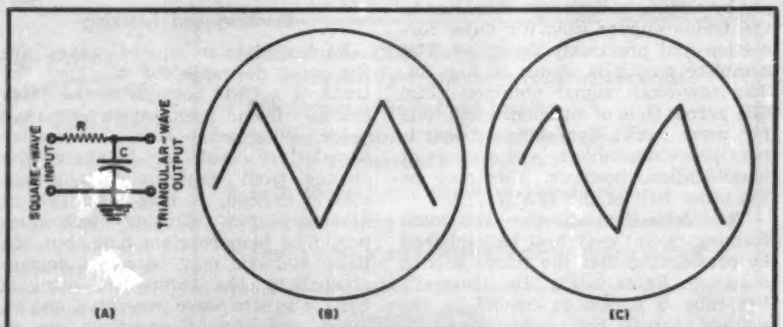


Fig. 4. Circuit (A) for producing triangular waves (B). At lower frequencies, curvature will occur (C) if R is increased too much while C is constant.

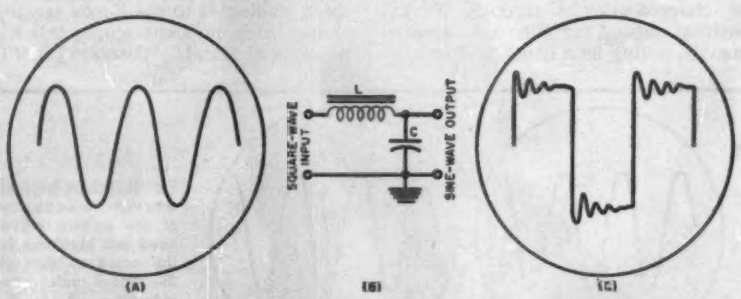
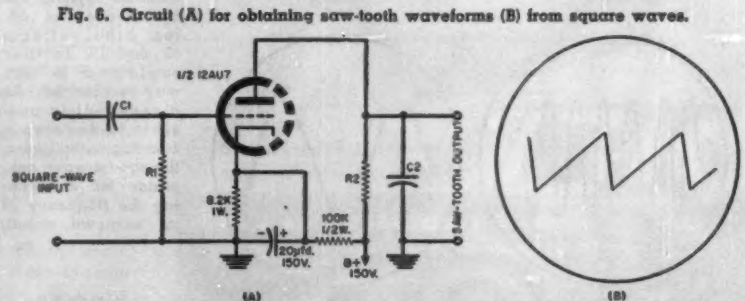


Fig. 5. High-frequency sine waves (A) can be extracted from low-fundamental square waves with tuned circuits (B). Low-"Q" circuits yield results as in (C).

Fig. 6. Circuit (A) for obtaining saw-tooth waveforms (B) from square waves.



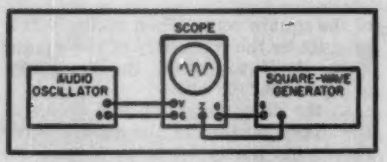


Fig. 7. Where a blanking pulse is desired, a square wave is the best type to use. As shown, the blanking square wave is fed to the Z-axis, with the audio or other signal to the Y-axis.

majority of better scopes have reasonably linear sweeps, few but the most expensive have almost perfect linearity. In addition to this, it is sometimes desirable to have a linear sweep at a frequency higher or lower than that which can be obtained from the built-in sweep of the instrument.

In either case, having a linear saw-tooth signal available which can be fed to the horizontal amplifier of the scope increases the usefulness of the instrument.

It is possible to obtain a saw-tooth signal having almost perfect linearity from the square-wave generator simply by adding a discharge capacitor to the triode clipper used for pulse formation and previously described. The complete circuit is shown in Fig. 6A. The saw-tooth signal obtained (Fig. 6B) across C_3 is of sufficient amplitude for most work. For some scopes, it may prove desirable to add a stage of amplification, however. This may be the other half of the 12AU7.

The operation of the saw-tooth forming circuit may best be explained by considering that the triode acts as a switch. Refer to Fig. 6A. Normally the tube is biased to cut-off by the voltage across the cathode resistor plus the positive voltage through the 100,000-ohm resistor. This allows C_3 to be charged slowly through R_3. On positive pulses, the tube can conduct heavily, acting as a short to discharge C_3. The charging action is repeated between positive pulses.

C_3R_1 is the simple differentiation circuit previously described. Since the discharge takes place only while the grid of the triode is driven positive, the pulse-width across R_1 determines the discharge (flyback or retrace) time. Hence, varying the time constant of C_3R_1 will vary the retrace time. Good results are obtained with the values given in Table 1.

The linearity obtained depends primarily upon the portion of the R_3C_3 charging curve used. For best results, keep the time constant of R_3C_3 at least several times larger than the time for one cycle of the square wave used. For 1000 cps, values of 20,000 ohms for R_3 and .1 μfd. for C_3 give satisfactory results.

The frequency of the saw-tooth is equal to the frequency (repetition rate) of the applied square wave. If the saw-tooth is used as the horizontal sweep of the scope for observing another signal, sync the square-wave generator with the signal to be observed.

Blanking and Marking

Rectangular or square waves are the most desirable for blanking the trace of a CRO because of the rapid change from positive to negative value. Where sine waves or similar signals are used for blanking, the change from light to dark is not clearly defined. A long discussion of blanking and marking techniques would be inappropriate here, but the basic methods may be easily demonstrated by the technician, using a CRO, a square-wave generator, and an audio oscillator. Connections are as shown in Fig. 7.

Note that the square-wave generator is connected to the Z-axis terminal of the CRO. On some scopes this may be marked "Grid," "Cathode," or "Intensity." The built-in linear sweep of the CRO is used. Adjust the "Intensity" control of the CRO for proper blanking with the square-wave signal used. If too much intensity is used, or if insufficient blanking signal is applied, complete blanking may not be obtained.

When the audio oscillator and the square-wave generator are adjusted to the same frequency, half of each cycle of the observed sine wave will be blanked out. This may be either the upper or lower half of the signal (Fig. 8A), or even another portion of the wave (Fig. 8B), depending on the phase relationships between the square wave and sine wave. (In Figs. 8A, 8B, and 8C, the blanked-out portion of the observed signal is shown in broken lines, although this would normally not be visible on the CRO screen.)

If the frequency of the sine wave is higher than that of the square wave, whole cycles will be blanked out, as in Fig. 8C. Here, the frequency of the sine wave is four times that of the square wave.

On the other hand, if the frequenc of the square wave is higher than th of the sine wave, the sine wave w be broken into a series of dashes and will appear as a dashed line (Fig. 8D). The number of "dashes" obtained depends on the ratio of square-wave frequency to sine-wave frequency. In Fig. 8D, the square wave is approximately 12 times higher in frequency than the sine wave.

Measuring the frequency of an unknown signal, irrespective of waveshape, is made comparatively easy using the techniques described, provided the frequency of the square-wave signal is known. This method offers many advantages over the conventional means of using Lissajous patterns formed with sine waves, for two reasons. First, where the unknown signal is not a sine wave, interpretation of the resultant Lissajous pattern becomes extremely difficult, if not impossible. Second, with wide frequency ratios (between known and unknown signals), the Lissajous pattern becomes too complex for rapid and accurate interpretation.

To demonstrate the technique, let us consider signals both higher and lower in frequency than the square wave used for blanking.

In Fig. 8C, two cycles of the unknown signal occur during an "unblanked" interval. This interval is equal to one half-cycle of the square wave, hence, the frequency of the unknown signal is four times that of the square wave. Up to ten cycles of the square wave may be counted easily on the screen of a 5" CRO (up to 20 cycles with horizontal expansion). Thus, it is possible to measure frequencies up to 20 or 40 times the highest frequency of the square-wave generator!

Where the unknown signal is lower in frequency than the square wave used for blanking, the unknown signal

(*Continued on page 129*)

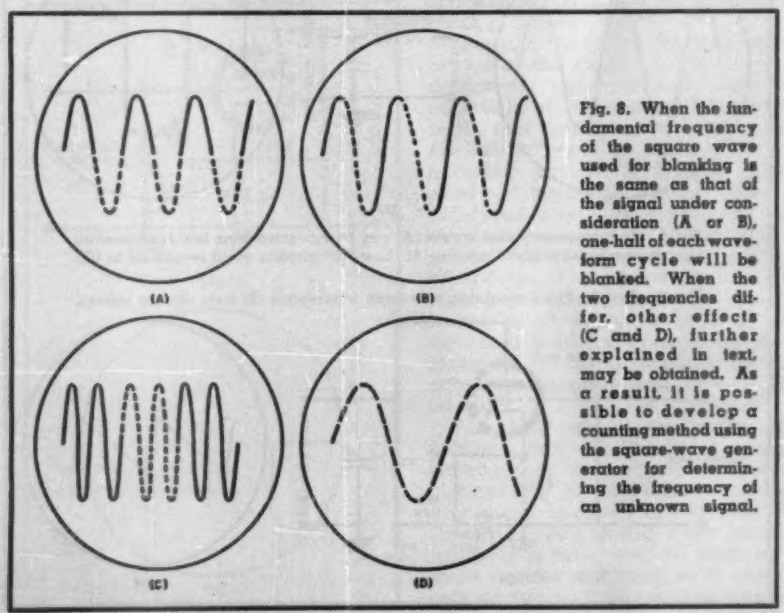


Fig. 8. When the fundamental frequency of the square wave used for blanking is the same as that of the signal under consideration (A or B), one-half of each waveform cycle will be blanked. When the two frequencies differ, other effects (C and D), further explained in text, may be obtained. As a result, it is possible to develop a counting method using the square-wave generator for determining the frequency of an unknown signal.

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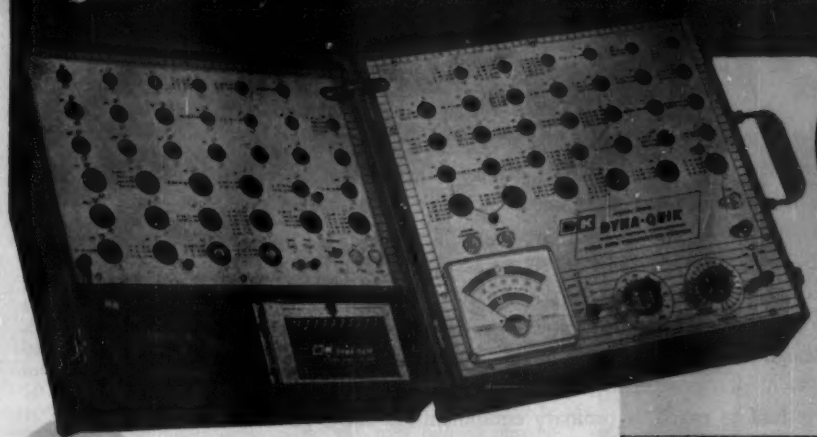

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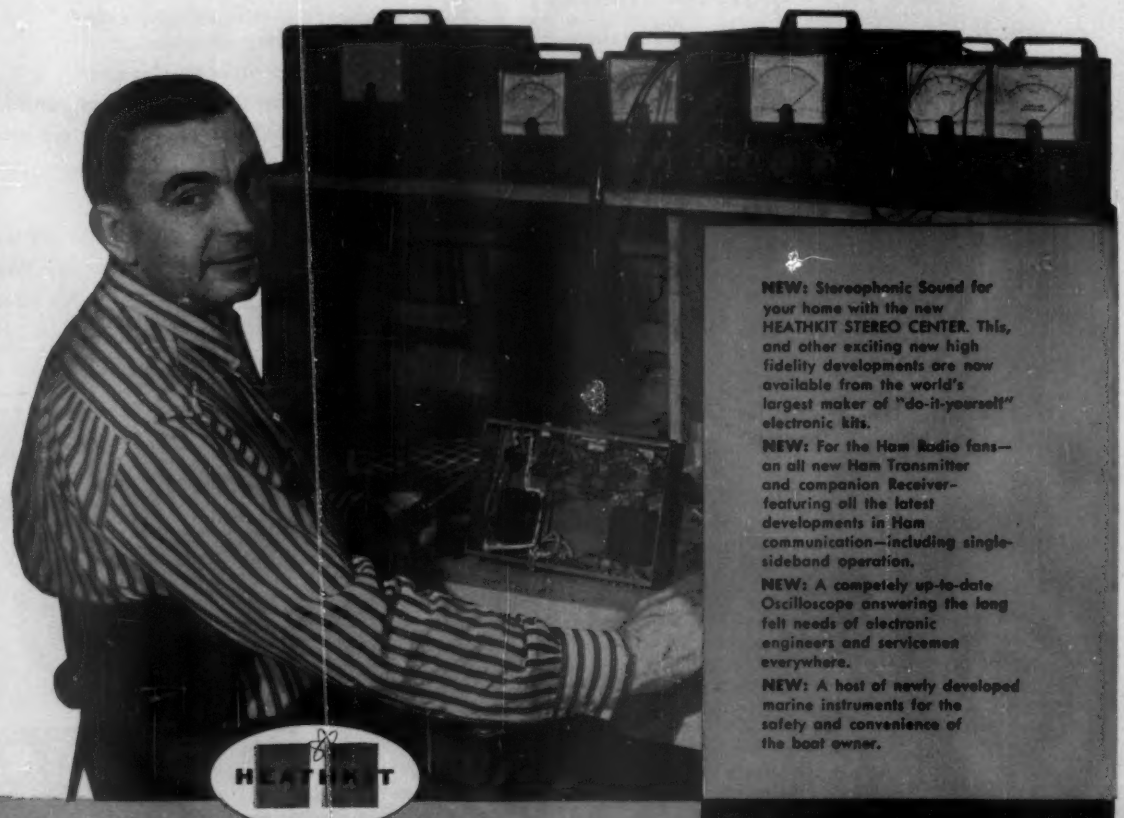

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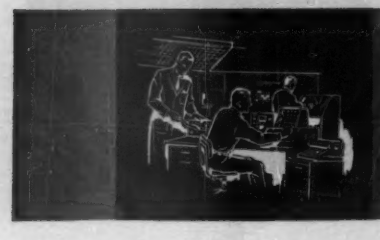

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ETCHED CIRCUIT VTVM KIT

The fact that this instrument is outselling all other VTVM's says a great deal about its accuracy, reliability, and overall quality. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Its attractive appearance as well as its performance will make you proud to own it. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit. An etched circuit board is employed for most of the circuitry, cutting assembly time and eliminating the possibility of wiring errors. It also assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (RMS), AC voltage (peak-to-peak), DC voltage and resistance. There are 7 AC (RMS) and DC voltage ranges of 1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4,000. Seven ohmmeter ranges providing multiplying factors of x 1, x 10, x 100, x 1000, x 10 k, x 100 k and x 1 megohm. Center scale resistance readings are 10, 100, 1000, 10 k, 100 k ohms, 1 megohm and 10 megohms. A zero-center scale db range is also provided. Battery and test leads included with kit. Shpg. Wt. 7 lbs.

HEATHKIT V-7A **$25.95**

World's largest selling VTVM kit

★ LARGE EASY-TO-READ 4½" 200 UA METER
★ 1% PRECISION RESISTORS EMPLOYED FOR HIGH ACCURACY

HEATHKIT C-3 **$19.50**

Checks all types of condensers accurately

HEATHKIT T-4 **$19.95**

Locate faults quickly by tracing signals

HEATHKIT SG-8 **$19.50**

Easy-to-build—prewound and calibrated coils

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately. Capacity measurements are made in four ranges of .00001 mfd-.005 mfd; .001 mfd-.5 mfd; .1 mfd-50 mfd; 20 mfd-1,000 mfd. Checks paper, mica, ceramic, and electrolytic condensers. Leakage test provides switch selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Electron beam "eye" tube indicates balance and leakage. A spring return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Measures resistance from 100 ohms to 5 megohms in two ranges. Shpg. Wt. 7 lbs.

VISUAL-AURAL SIGNAL TRACER KIT

Here is a brand new signal tracer completely redesigned with compact dimensions and new circuit layout. Features built-in speaker and electron beam "eye" tube for signal indication and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. RF and audio inputs are provided in one convenient probe with switch on probe to select either input. Useful for checking microphones, phono cartridges, record changers, tuners, etc. Makes a handy substitution speaker for servicing TV sets at the shop. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 6 lbs.

RF SIGNAL GENERATOR KIT

Save valuable time in aligning RF tuned circuits of all kinds with this easy-to-use kit. Also a quick way to trace signals in faulty RF, IF and audio circuits. Designed for general service applications, the SG-8 covers 160 kc to 110 mc on fundamentals in five bands, and from 110 mc to 220 mc on calibrated harmonics. The entire oscillator circuit is built on a special sub-chassis, using prewound and calibrated coils. No further calibration is required so it is ready to use as soon as construction is completed. RF output is in excess of 100,000 microvolts, controlled by both step and continuously variable controls. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 15, Mich.**

Beautifully Styled with Plenty of Room for the Most Complete Stereo System

AVAILABLE IN THE FOLLOWING MODELS:
Model SE-1B—Stereo Equipment Cabinet (birch)
Model SE-1M—Stereo Equipment Cabinet (mahogany)
$149.95 ea.

Model SC-1BR—Stereo Wing Speaker Enclosure (birch—right end)
Model SC-1BL—Stereo Wing Speaker Enclosure (birch—left end)
Model SC-1MR—Stereo Wing Speaker Enclosure (mahogany—right end)
Model SC-1ML—Stereo Wing Speaker Enclosure (mahogany—left end)
$39.95 ea.

STEREO EQUIPMENT CABINET KIT

Imagine!... Stereophonic sound in your own home. This superbly designed cabinet holds all of your hi-fi stereo equipment and lends striking elegance to your living room. The attractive gold and black panels, trim and hardware brilliantly highlight the overall effect. Rich toned grille cloth, flecked in gold and black, complement the cabinet. The unit has ample room provided for an AM-FM tuner, tape deck, stereo preamplifier, amplifiers, record changer, record storage and speakers. Beautifully grained ¾" solid core Philippine mahogany or select birch plywood is used for construction. The top features a shaped edge and sliding top panel for easy access to the stereo tape deck and stereo preamplifier. Sliding doors are employed for convenient front access to the changer and record storage compartment. All parts of the cabinet are precut and predrilled for simple assembly. The speaker wings and center cabinet may be purchased separately if desired. Note: the kit is delivered equipped with panels precut to accommodate Heathkit components and also blank panels to cut out for your own equipment. Measurements of the individual component areas follow: tape deck and preamplifier area 20¾" L. x 17¾" W. x 10" D., record changer area 21" W. x 16" D. x 9⅝" H., record storage area 22⅝" W. x 14½" H. x 12½" D., speaker wing area (inside) 14" W. x 29½" H. x 15¾" D., AM-FM Tuner area 20½" W. x 5¼" H. x 14" D., amplifier (2 areas) 15¼" W. x 10¾" H. x 13¼" D.

Model HH-1B Birch
Model HH-1M Mahogany
Now only $299.95 each

The Same Superior Performance At a New Low Price

HEATHKIT SS-2 **$39.95**

OPTIONAL LEGS EXTRA

Economical Hi-Fi For Your Home

"LEGATO" HI-FI SPEAKER SYSTEM KIT

The increasing sales of the Legato has made more economical quantity production possible so we are passing the savings on to you by offering you this magnificent speaker system at a reduced price. Truly a "queen" among hi-fi speaker systems, the Legato was specially designed to meet and surpass the most stringent requirements of high fidelity sound reproduction. Two 15" Altec Lansing low frequency drivers cover frequencies of 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. A unique crossover network is built in making electronic crossovers unnecessary. Internal reflections are absorbed by splayed back panel and a 3" fiber glass lining. The Legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Cabinet construction is ¾" veneer surface plywood in either African mahogany or white birch and measures 41" L. x 22¼" D. x 34" H. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

True high fidelity performance at modest cost make this basic speaker system a spectacular buy for any hi-fi enthusiast. The amazing performance of this popular kit is made possible by the use of high quality speakers in an enclosure specially designed to receive them. The cabinet is a ducted port bass reflex type enclosure 11½" H. x 23" W. x 11¾" D. It features an 8" mid range woofer to cover 50 to 1600 CPS and a compression-type tweeter with flared horn covering 1600 to 12,000 CPS. Both speakers are by Jensen. The adjustable flared tweeter horn allows speaker to be used in either upright or horizontal position. The cabinet is constructed of ½" veneer surfaced plywood suitable for light or dark finish of your choice. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 25 lbs.

Attractive brass tip accessory legs convert SS-2 into attractive consolette. Legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26 $4.95

with a Heathkit Stereo System

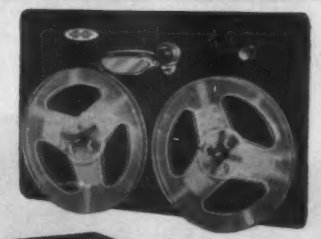
HEATHKIT

HIGH FIDELITY TAPE RECORDER KIT

Popular request for high quality, low cost tape recording and playback facilities have prompted the addition of this fine unit to our line. The TR-1A provides monaural record /playback with fast forward and rewind functions. Incorporates separate erase and combination record /playback heads. Two speeds, 7½ and 3¾ IPS, are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-65,000 CPS. The extremely simple mechanical assembly is ideally suited to kit construction. One control lever selects all functions on deck, greatly simplifying operation. Mount in vertical or horizontal position. The model TE-1 record /playback tape preamplifier, supplied with the mechanical assembly, provides NARTB playback equalization. A record interlock prevents accidental tape erasure. Recording level is indicated by a 6E5 "magic eye" tube. A two-position input selector switch provides for mike or line input. Separate record and playback gain controls. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Templates and instructions are provided to cut out panels for mounting. Overall dimensions of tape deck and preamp are 15½" W. x 13½" H. x 8" D. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. (Tape mechanism not sold separately.) Shpg. Wt. 22 lbs.

TAPE RECORDER ELECTRONICS KIT

The model TE-1 Electronics Kit can be purchased separately to replace the electronics in your present tape recorder, or used in addition to it for stereo playback of pre-recorded tapes where a second playback channel is required. Circuit may be modified for use with different head types. Shpg. Wt. 9 lbs.

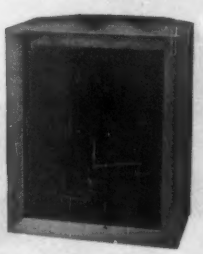


HEATHKIT TR-1A **$99.95**

(Includes tape deck, tape recorder electronics, mike and roll of tape.)

Make Your Own Home Recordings

HEATHKIT TE-1 **$39.95**



HEATHKIT SS-1B **$99.95**

Fill out the Hi-Fi Range of Your SS-2 Speaker

HEATHKIT SW-1 **$24.95**

Save Time Rewinding Tape

HEATHKIT TK-1 **$9.95**

All The Tools You Need For Building Heathkits

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

This is not a complete speaker system in itself, but is designed to extend the range of the SS-2. The SS-1B uses a 15" woofer and a small super tweeter to supply the very high and very low frequencies to fill out the response of the basic SS-2. The SS-2 and SS-1B when used together, form an integrated four speaker system. The SS-2 and SS-1B combination provide an overall response of ± 5 db from 35 to 16,000 CPS. The kit includes circuit for crossover at 600, 1600 and 4,000 CPS. Impedance is 16 ohms and power rating is 35 watts. A control is also provided to limit output of super tweeter. The handsome cabinet measures 29" H. x 23" W. x 17½" D. Constructed of beautiful ¾" veneer surface plywood. Complete step-by-step instructions make this kit easy to build. No woodworking experience required. Shpg. Wt. 80 lbs.

"SPEEDWINDER" KIT

This handy device leaves your tape recorder free for operation while it rewinds tape at the rate of 1200' in 40 seconds. Prevents unnecessary wear to the tape and recorder by eliminating wear against guides and heads. It will handle up to 10½" tape reels as well as 800' reels of 8 and 16 millimeter film. A very useful aid to operators of movie projection equipment. The Heathkit Speedwinder features an automatic shutoff which prevents whipping of tape when it has rewound. A manual shutoff is also provided. An automatic braking device is built in for protection against power failure. Driven by a heavy duty four pole motor. Handsome cabinet is constructed of furniture grade plywood. Step-by-step instructions are provided to make this kit easy to assemble even by one with no experience. Shpg. Wt. 12 lbs.

COMPLETE TOOL SET

A clear illustration of just how easy Heathkit building is. The pliers, diagonal sidecutters, two screw drivers and soldering iron are all the basic tools you need for building practically any Heathkit. Pliers and sidecutters are equipped with insulated rubber handles. The American Beauty soldering iron has a replaceable tip to facilitate cleaning. All the tools are of top quality case hardened steel for rugged duty and long life. With these simple, inexpensive tools in your hand you need not be afraid to tackle the most elaborate kit. The manual included with this handy kit provides you with many useful tips on the use and care of your tools. It shows the all important step of making proper solder connections. A truly worthwhile investment for the beginner in electronic kit building. Shpg. Wt. 3 lbs.

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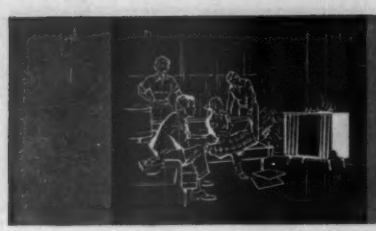


Plan Your Hi-Fi System...

HEATHKIT SP-2 **$56.95**

Model SP-1 (monaural) $37.95

Model C-SP-1 (converts SP-1 to SP-2) $21.95

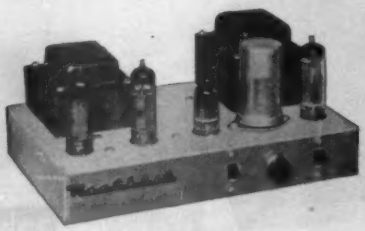
Control both stereo channels simply and conveniently

MONAURAL-STEREO PREAMPLIFIER KIT

This expertly designed preamplifier provides all the controls required for either standard monaural (single channel) or stereo (dual channel) sound reproduction. Features building block design . . . you can start with a basic preamplifier and add a second channel for stereo later on, without rewiring. Second channel plugs in for fast conversion. The complete model SP-2 (stereo) features twelve separate inputs, six on each channel with input level controls. Six dual-concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch (separate on-off switch). The function switch provides settings for stereo, two-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. Tape input has NARTB equalization and input selector provides for RIAA, LP, 78 record compensation. EF86 tubes are used in the input stages along with hum balance controls to assure low hum and noise. Two cathode follower outputs with level controls provided in addition to two separate tape outputs for stereo recording. A remote balance control with twenty feet of cable allows balancing the stereo system from listening position. Construction is greatly simplified through the use of two printed circuit boards (one in each channel) and encapsulated printed circuits. The beautiful vinyl clad steel cover has leather texture in black with inlaid gold design. Built-in power supply.

HEATHKIT WA-P2 **$19.75**

Finger-tip controls for your operating convenience



HEATHKIT UA-1 **$21.95**

A low cost versatile performer

"MASTER CONTROL" PREAMPLIFIER KIT

Designed as a control center for basic amplifiers the WA-P2 provides you with true high fidelity performance for the finest audio systems. Five switch-selected inputs accommodate a record changer, tape recorder, AM-FM tuner, TV receiver, microphone, etc., each with level control. Provision is also made for a tape recorder output. Ideal for "remote" installations, the WA-P2 features a low impedance cathode-follower output circuit allowing greater length of output lead. Full frequency response is obtained within ±1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for records through separate turnover and rolloff switches for LP, RIAA, AES, and early 78's. A special hum balance control allows setting for minimum hum level. Power for operation is required from basic amplifier or external source. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12-WATT AMPLIFIER KIT

A true high fidelity performer in every sense of the word, the UA-1 makes an ideal basic amplifier for any hi-fi system and is a perfect addition to gear your present hi-fi system for stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12 watt output. The on-off switch is located right on the chassis and an octal socket is provided for connecting a preamplifier for remote control operation. The specially designed output transformer provides excellent stability and frequency response. Taps for 4, 8 and 16 ohm speakers, with switched damping for "unity" or "maximum" on the 16-ohm tap. An input level control is provided for use in wired music systems where a preamplifier is not required. This versatile unit is the latest addition to the fine line of Heathkit basic amplifiers. Shpg. Wt. 13 lbs.

With Flexible Heathkit Components

HEATHKIT

DELUXE AM-FM TUNER KIT

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe AM-FM combination tuner to bring you the very finest in program sources, for your listening enjoyment. Features include three circuit boards for easy construction and high stability—prewired, prealigned FM front end—built-in AM rod antenna—tuning meter—AFC (automatic frequency control) with on-off switch and flywheel tuning. AM and FM circuits are separate and individually tuned making it ideal for stereo applications. Cathode follower outputs with individual controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. The unique IF limiter design automatically provides the number of limiting and IF stages required for smooth non-flutter reception. The silicon diode power supply is extremely conservatively rated and is fuse protected assuring long service life. A tuning meter shows when the station is tuned-in for clearest reception on AM or FM. Use of three circuit boards greatly simplifies construction of circuit, you do only a minimum of wiring. All IF transformers and coils are prealigned so it will be ready to operate as soon as construction is completed. Appearance of this top-quality unit is further enhanced by the vinyl-clad steel cover in black with inlaid gold design. A multiplex jack is provided for addition of converter unit to receive multiplex stereo broadcasts on FM. A top dollar value.

HEATHKIT PT-1 $89.95

A deluxe AM-FM tuner combination loaded with extras!

HEATHKIT BC-1A $26.95

Wide range broadcast reception

HEATHKIT FM-3A $26.95

Enjoy static-free FM entertainment

HIGH FIDELITY AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuit features broad bandwidth to assure low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc, with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent and the tuner covers the entire broadcast band from 550 to 1600 kc. Quiet performance is assured by a 6 db signal-to-noise ratio at 2.5 uv. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

HIGH FIDELITY FM TUNER KIT

FM programming, your least expensive source of high fidelity will provide you with years of real enjoyment. This beautifully styled FM tuner features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting to pull in stations with clarity and full volume. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit, making special alignment equipment unnecessary. Edge-lighted glass slide rule dial for easy tuning. You need not wait to have FM in your home at this low price. Shpg. Wt. 8 lbs.

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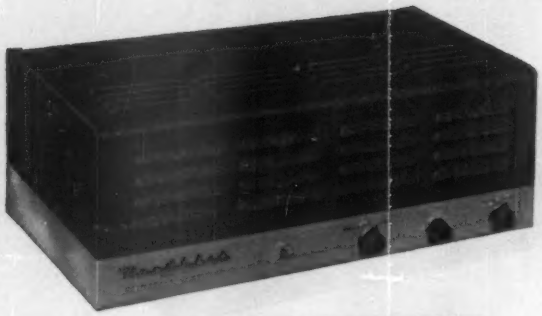
You can be sure you're buying High Fidelity



HEATHKIT W-7M **$54.95**

55 watts of hi-fi power at only $1 per watt

★ BEAUTIFULLY STYLED IN BLACK AND GOLD

★ UNITY OR MAXIMUM DAMPING

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

Another Heathkit first! An honestly rated high power amplifier with many top quality features at less than a dollar per watt. Full audio output is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Unique paired output connections permit instant switch selection of "unity" or "maximum" damping factors for all 4, 8 or 16 ohm speakers. Each output has an optimized current feedback circuit for unity damping so that there will be no compromise in performance when any of the impedances is used. This current feedback circuitry is entirely shorted out when not in use to obtain the highest possible damping factor. Features include level control and "on-off" switch right on the chassis plus provision for remote control from preamp, etc. Famous "bas-bal" circuit conveniently balances EL-34 output tubes. These heavy duty push-pull tubes operate into a high quality tapped-screen transformer designed especially for this unit. A 70-volt output on the transformer provides for P.A. or large music systems. The silicon diode power supply features a protection device that controls current until tubes have warmed up, greatly increasing service life of all components. The stylish black and gold case measures 6" H. x 8½" D. x 15" W. Convenient pilot light on the chassis. Thoughtful circuit layout makes this kit easy to build. Dollar for watt you can't beat this buy. Shipped express only. Shpg. Wt. 28 lbs.

HEATHKIT W-6M **$109.95**

Plenty of Reserve Power Without Distortion

"HEAVY DUTY" 70-WATT HI-FI AMPLIFIER KIT

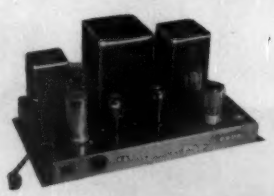
Here is an amplifier that will provide the extra "push" needed to drive any of the fine speaker systems available today, for truly fine performance at any power level. Silicon-diode rectifiers are used to assure long life and a heavy duty transformer gives you extremely good power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohms or 70 volt output and the correct feedback resistance. Frequency response at 1 watt is from 5 CPS to 80 kc with controlled HF rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 CPS and IM distortion is below 1%, 60 and 6,000 CPS. Hum and noise 88 db below full output. Metered balance circuit. Designed especially for easy assembly and years of dependable service. Shipped express only. Shpg. Wt. 52 lbs.

HEATHKIT W-5M **$59.75**

Top-Flight Performance for the Critical Listener

25-WATT HI-FI AMPLIFIER KIT

Considered top value in its power class by leading independent research organizations, the W-5M incorporates all the design features required by the super critical listener. Features include a specially designed Peerless output transformer and KT66 tubes. The circuit is rated at 25 watts and will follow instantaneous power peaks of a full orchestra up to 42 watts. A "tweeter saver" suppresses high frequency oscillation and a new type balancing circuit facilitates adjustment of the "dynamic" balance between output tubes. Frequency response is ±1 db from 5 CPS to 160,000 CPS at 1 watt and within 2 db from 20 to 20,000 CPS at full 25 watts output. Harmonic distortion is less than 1% at 25 watts and IM distortion is 1% at 20 watts (60 and 3,000 CPS, 4:1). Hum and noise are 99 db below 25 watts for truly quiet performance. Rich black and gold colored styling. Shipped express only. Shpg. Wt. 31 lbs.



HEATHKIT W4-AM **$39.75**

Faithful Sound Reproduction with Minimum Investment

20-WATT HI-FI AMPLIFIER KIT

This fine amplifier will amaze you with its outstanding performance. It features a true Williamson circuit with extended frequency response, low distortion, and low hum levels. Enjoy true hi-fi with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-Standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extends from 10 CPS to 100 kc within ±1 db at 1 watt assuring you of full coverage of the audio range. Clean, clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms to match the speaker system of your choice. An outstanding performer, this investment will bring you years of listening enjoyment. Shipped express only. Shpg. Wt. 28 lbs.

All basic amplifiers recommended for use with model WA-P2, SP-1 or SP-2 preamplifiers

...When You Buy Heathkits

HEATHKIT

"BOOKSHELF" 12-WATT AMPLIFIER KIT

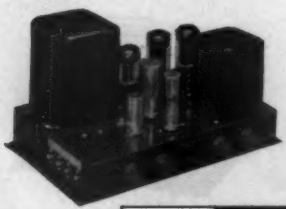
The model EA-2 combines eye-pleasing style and color with many extra features for high quality sound reproduction. This fine amplifier provides full range frequency response from 20 to 20,000 CPS within ±1 db. Harmonic distortion is less than 1% at full 12 watt output over the entire range (20-20,000 CPS). IM distortion is less than 1.5% at 12 watts with low hum and noise. Miniature tubes are used throughout the advanced circuitry, including EL84 output tubes in a push-pull tapped-screen output circuit using a special designed output transformer. Transformer has taps at 4, 8 and 16 ohms. The model EA-2 has its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono and tuner. The mag phono input features RIAA equalization. Separate bass and treble controls are provided with boost and cut action. A special hum-balance control assures quiet operation. The luxury styled cabinet has a smooth simulated leather texture in black with inlaid gold design and is constructed of vinyl plastic bonded to steel. It resists scuffing, wear, abrasion, and chemicals. The front panel features brushed-gold trim and buff knobs with gold inserts for a very pleasing appearance. An amber neon pilot lamp indicates when the amplifier is on. Cabinet measures 12½" W. x 3 3/16" D. x 4⅜" H. making it suitable for use on a bookshelf, end table, etc. High quality is emphasized throughout for performance matching amplifiers costing many times more. Shpg. Wt. 15 lbs.

HEATHKIT EA-2 **$28.95**

Combines beauty, style and quality

★ LESS THAN 1% DISTORTION AT FULL OUTPUT OVER ENTIRE AUDIO RANGE.

★ BUILT-IN PREAMPLIFIER



HEATHKIT A9-C **$35.50**

A Bargain Package of Power and Performance

HEATHKIT AV-3 **$29.95**

Invaluable for Hi-Fi Testing

HEATHKIT AW-1 **$29.50**

Measure Exact Power Output

GENERAL-PURPOSE 20-WATT AMPLIFIER KIT

The A9-C combines a preamplifier, main amplifier and power supply all on one chassis providing a compact unit to fill the need for a good high fidelity amplifier with a moderate cash investment. Designed primarily for home installations, it is also capable of fulfilling P.A. requirements. The preamplifier section features four separate switch selected inputs. Separate bass and treble tone controls offer 15 db boost and cut. A true high fidelity performer, the A9-C covers 20 to 20,000 CPS within ±1 db. Front panel is detachable, and can be installed on the outside of a cabinet where the chassis comes through, for custom installations. A fine unit with which to start your hi-fi system. Shpg. Wt. 23 lbs.

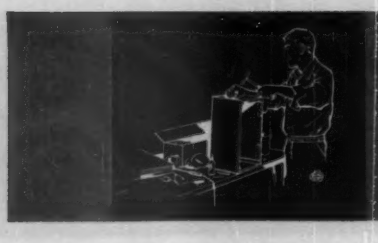
AUDIO VTVM KIT

Critical AC voltage measurements are made easy with this high quality vacuum tube voltmeter which emphasizes stability, broad frequency response and sensitivity. Features large 4½" 200 microampere meter, with increased damping in the meter circuit for stability in low frequency tests. Extremely high voltage range handles measurements from a low value of 1 millivolt to a maximum of 300 volts. AC (RMS) voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 to +52 db. Employs 1% precision multiplier resistors for maximum accuracy. High input impedance (1 megohm at 1,000 CPS). Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

AUDIO WATTMETER KIT

Here is a fine meter to accurately measure output wattage. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w and 50 w full scale. Five switch selected db ranges cover −10 db to +30 db. All indications are read directly on the large 4½" 200 ua meter. Frequency response is ±1 db from 10 CPS to 250 kc. External or internal load resistors are selected with convenient front panel switch. Non-inductive load resistors are built in for 4, 8, 16 or 600 ohms impedance. Precision multiplier resistors are used for high accuracy and incorporates a crystal diode bridge for wide-range frequency response. Modern styling and convenient front panel design. Cabinet is ventilated to allow efficient cooling of load resistors. Shpg. Wt. 7 lbs.

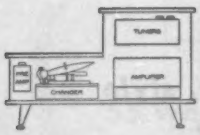
HEATH COMPANY • a subsidiary of Daystrom, Inc. • Benton Harbor 15, Mich.



Easy to Buy - Easy to Build - Easy to Use...

HEATHKIT
CE-1
$43.95 each

CONTEMPORARY
Model CE-1B Birch
Model CE-1M Mahogany



TRADITIONAL
Model CE-1T Mahogany

Combine all your Hi-Fi equipment in this attractive cabinet

CHAIRSIDE ENCLOSURE KIT

This Chairside Enclosure lets you combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit into the space provided. Adequate room is available in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. The enclosure is flexible enough to give you a large choice in component installation. If only one tuner and the preamplifier are used, the two units can be installed in the tilt-out drawer, or if more convenient, either unit can be placed in the space provided in front of the changer compartment. The tilt-out shelf can be installed on either right or left side and the lift-top lid is similarly designed to lift from either side depending on your choice during construction. Good ventilation is achieved through appropriately placed slots in the bottom and back of the enclosure. Overall dimensions are 18"W. x 24" H. x 35½" D. The changer compartment measures 17¾" L. x 16" W. x 9⅝" D. All parts are precut and predrilled for easy assembly and attractive hardware is supplied to match each style. The contemporary cabinet is available in either mahogany or birch and the traditional cabinet is available in mahogany only. Furniture grade plywood can be finished to your taste. Shpg. Wt. 46 lbs.

HEATHKIT **AG-9A** **$34.50**

Your own source of Hi-Fi audio signals

HEATHKIT **AA-1** **$49.95**

3 Audio test instruments in one compact unit

HEATHKIT **HD-1** **$49.50**

Check amplifier distortion quickly

AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals from 10 CPS to 100 kc. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1, 3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 CPS. Shpg. Wt. 8 lbs.

AUDIO ANALYZER KIT

Complete high fidelity testing facilities are yours in the AA-1. It combines the functions of three separate instruments; an AC VTVM, audio wattmeter and a complete IM analyzer with filters and high and low frequency oscillators built in. VTVM ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Db scale reads from −65 to +52 dbm. Wattmeter ranges are: .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100% full scale. Provides internal load resistors of 4, 8, 16 or 600 ohms. Combining and consolidating functions reduces the number of test leads and controls required for the same test. Complete instructions are provided for easy assembly, also valuable information on use of instrument. Shpg. Wt. 13 lbs.

HARMONIC DISTORTION METER KIT

Valuable in both designing and servicing of audio circuits, the HD-1 used with an audio signal generator, will accurately measure harmonic distortion at any or all frequencies between 20 and 20,000 CPS. Distortion is read on panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio is measured on a separate meter scale calibrated in db. Features high input impedance (300,000 ohms) and 1% precision resistors in the VTVM voltage divider circuit for excellent sensitivity and accuracy. High quality components insure years of dependable service. Complete instructions provided for easy assembly and operation. Shpg. Wt. 13 lbs.

Heathkits are Your Best Dollar Value

HEATHKIT

TRANSISTOR PORTABLE RADIO KIT

The overwhelming sales of this outstanding transistor portable have made a substantial price reduction possible . . . in addition, an all new plastic molded case adds the finishing touch to the exceptional circuitry. Six name-brand (Texas Instrument) transistors are used for extra good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides excellent tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned so it is ready for service as soon as construction is completed. A touchup in alignment is easily accomplished on a station by following simple instructions in manual. Alignment tool furnished. Has built-in rod-type antenna for reception in all locations. Six standard size "D" flashlight cells are used for extremely long battery life (between 500 and 1000 hours) and they can be purchased almost anywhere. Cabinet is two-tone blue molded plastic with pull-out carrying handle. Dimensions are 9½" L. x 7¼" H. x 4" D. Shpg. Wt. 6 lbs.

Model XR-1-L: Identical to XR-1-P except in genuine leather case. Rich, warm sun-tan tone. Leather carrying strap included. Shpg. Wt. 7 lbs.

Leather Case: can be purchased separately if desired. Fits all XR-1P's and XR-1's. No. 93-1. Shpg. Wt. 3 lbs. $6.95.

MODEL XR-1-L
$34.95

HEATHKIT XR-1-P **$29.95**

Newly designed plastic case . . . new low price!

★ 4" X 6" SPEAKER FOR "BIG SET" TONE
★ LONG BATTERY LIFE (500 to 1000 Hours)

HEATHKIT CT-1 **$7.95**

Test condensers right in the circuit

HEATHKIT DF-1 **$54.95**

Pin-point your exact location

HEATHKIT FD-1 **$35.95** each
(6 volt model FD-1-6)
(12 volt model FD-1-12)

Detects gas fumes

HEATHKIT MC-1 **$42.95**

Save your boat batteries

IN-CIRCUIT CAPACI-TESTER KIT

Check most capacitors for "open" or "short" right in the circuit with this handy kit. Detects open capacitors from about 50 mmf up, not shunted by an excessively low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage nor check electrolytic condensers.) Employs a 60-cycle frequency for the short test and a 19 megacycle frequency for the open test. Uses electron beam "eye" tube for quick indication. Test leads included. Shpg. Wt. 5 lbs.

TRANSISTOR RADIO DIRECTION FINDER KIT

This transistor radio compass will double as a portable radio. Covers the standard broadcast band from 540 to 1600 kc. Ideal for use aboard boats and also on land by hunters, hikers, etc. A directional high-Q ferrite antenna rotates from the front panel to obtain a fix on a station. A 1 ma meter serves as null and tuning indicator. Prealigned IF transformers—six transistor circuit. Powered by tiny 9-volt battery with spare included. Dimensions 7½" W. x 5⅜" H. x 5⅛" D. Shpg. Wt. 5 lbs.

FUEL VAPOR DETECTOR KIT

Protect your boat and passengers against fire and explosion with one of these fuel vapor detector kits. Indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot lamp shows when the detector is operating. Easy to build and install, even by one not having previous experience. Operates from your boat battery. The kit is complete with heavy-duty neoprene insulated cable and includes spare detector unit. Shpg. Wt. 4 lbs.

MARINE CONVERTER KIT

Charge 6 or 12 volt batteries with this marine converter and battery charger. A panel mounted 25 ampere meter continuously monitors the charging current. Moisture and fungus proofed for rugged marine use. Convection cooling prevents unsafe temperature rise. The MC-1 has no moving parts, tubes nor blowers to wear out or break. Mounting brackets are supplied for easy installation on any boat. Ideal for keeping batteries fully charged or to supply extra current for appliances. Shpg. Wt. 16 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 15, Mich.**

New Styling - New Features...

HEATHKIT TX-1 **$229.50**

Complete Versatility for Top-Notch Amateur Communications

★ NEWLY DESIGNED VFO—ROTATING SLIDE RULE DIAL
★ MODERN STYLING—PROVISION FOR SSB ADAPTER

"APACHE" HAM TRANSMITTER KIT

Fresh out of the Heath Company laboratories, the brand-new "Apache" model TX-1 ham transmitter features modern styling and the latest in circuitry for extra fine performance. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. These SSB adapters will be available in the near future. A compact, stable and completely redesigned VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters. (11M with crystal control). This unit also has adjustable low level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL-34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

HEATHKIT DX-20 **$35.95**

An Ideal Code Transmitter

HEATHKIT DX-100 **$189.50**

You'll be Proud to Own This Outstanding Performer

HEATHKIT DX-40 **$64.95**

Phone & CW Facilities at Low Cost

DX-20 CW TRANSMITTER KIT

Designed especially for CW work, the DX-20 features high efficiency at low cost. An ideal rig for the novice or advanced-class CW operator. Plate power input is 50 watts, and covers 80, 40, 20, 15, 11 and 10 meters with single knob bandswitching. Features a single 6DQ6A tube in the final amplifier stage and a 6CL6 as a crystal oscillator. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long service life. Complete shielding to minimize TVI. Removable metal pull-out plug on left end of cabinet provides access for crystal changing. Very easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

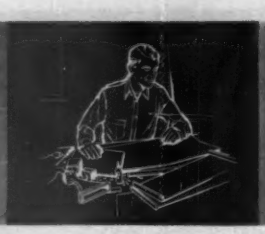
DX-100 PHONE AND CW TRANSMITTER KIT

Well known for its high quality and fine performance the DX-100 features a built-in VFO, modulator, and power supply, complete shielding to minimize TVI, and a pi network coupling to match impedances from 50 to 600 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW, for clean strong signals on all ham bands from 10 to 160 meters. Single knob bandswitching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as potted transformers, silver-plated or solid coin silver switch terminals, aluminum-heat dissipating caps on the final tubes, copper plated chassis, etc. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

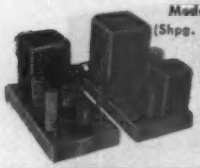
DX-40 PHONE AND CW TRANSMITTER KIT

An outstanding buy in its power class the DX-40 provides both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or controlled carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built in and single-knob bandswitching is combined with the pi network output circuit for complete operating convenience. Complete shielding to minimize TVI. Provision is made for three crystals. A four-position switch selects any of the three crystals or a jack for external VFO. Crystal sockets are reached through access door in rear of cabinet. High quality D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.



Choose from a wide variety of Heathkits

DUAL-CHASSIS 20 WATT HI-FI AMPLIFIER KIT



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(Shpg. Wt. 29 lbs.)
$49.75

12" UTILITY SPEAKER

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(Shpg. Wt. 7 lbs.)
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Model AR-3
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DIRECT-READING CAPACITY METER KIT

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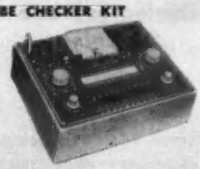

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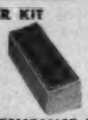

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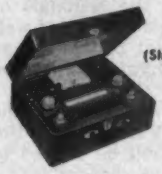

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TV PICTURE TUBE TEST ADAPTER FOR TC-2 AND TC-2P

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Model BE-5
(Shpg. Wt. 21 lbs.)

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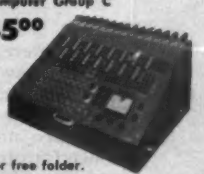
ELECTRONIC ANALOG COMPUTER KIT

Full Computer Group C

$945.00



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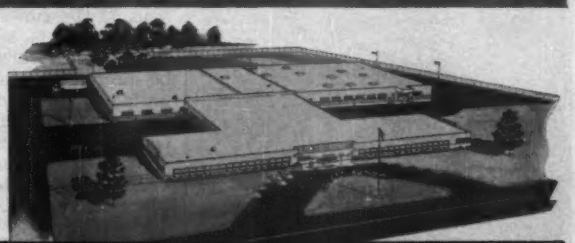

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STEREO "MUSIC WALL"

David Bogen Company, P. O. Box 500, Paramus, N. J. has developed a stereo "Music Wall" which is designed to overcome distaff objections to hi-fi gear in the living room.

By housing the company's dual

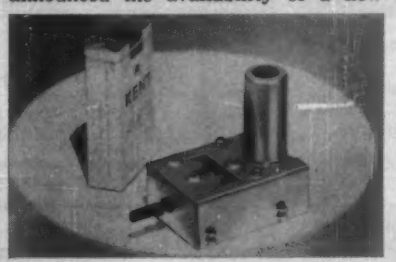
stereo 12-watt amplifier-preamp, four speed stereo changer, and AM-FM tuner in two furniture-finished wood cabinets which can be mounted on the living room wall, the family can have its stereo music and the necessary floor space for other activities. Record storage space is provided in the cabinet housing the tuner.

The cabinets are currently available in walnut finish with other finishes to be offered at a later date. The stereo units are provided without speakers so that users may select speaker systems to meet room requirements.

Further information on the "Music Wall" is available from the manufacturer on request.

LOW-COST FM TUNER

Granco Products, Inc., 36-07 20th Avenue, Long Island City 5, N. Y. has announced the availability of a new



tuning device which substantially reduces the cost of manufacturing FM receivers.

No larger than a pack of king-size cigarettes, the sensitivity of the unit is 5 μv. for 20 db of quieting. According to the company, audio characteristics are in keeping with the demands of high-fidelity FM broadcasting and well beyond even the widest of wide-range AM transmissions. Drift is said to be negligible.

The tuner will be incorporated in the firm's 1959 line of FM and AM-FM radio receivers and will be offered to other manufacturers at a later date.

POWER MEGAPHONE

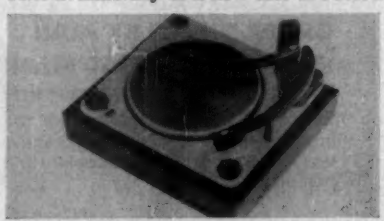
A new power megaphone for hand-held, portable sound projection is being offered by *Argonne Electronics Mfg. Corp.,* 165-11 South Road, Jamaica 33, N. Y.

The unit features a rubber-rimmed spun aluminum reflex horn measuring 12½ inches long and with a mouth diameter of 8¼"; high audio power and directivity giving a range of 1000 feet; a pistol grip and grip switch for ease of handling, aiming, and starting; operation from four low-cost "D" batteries; and non-linear current limiter for maximum battery life.

Catalogued as the AR230, the new megaphone weighs only 4½ pounds.

CHANGERS FOR STEREO

Rockbar Corporation, Mamaroneck, N. Y., U. S. sales representative for *Collaro, Ltd.,* has announced the current availability of a new line of record



changers which has been specifically engineered for stereo applications.

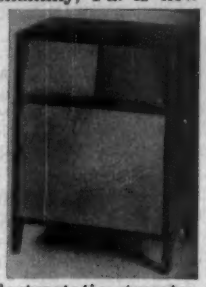
The three new changers are: "The Continental" (Model TSC-840), "The Coronation" (Model TSC-740), and "The Conquest" (Model TSC-640). The first unit features a two-piece arm with the all-new 5-terminal plug-in head. The counterbalanced transcription-type tonearm will accept any standard stereo or monaural cartridge. The changer has four speeds, a manual switch to permit playing a single record or portion of a record, wow and flutter of 0.25% r.m.s. at 33⅓ rpm, automatic shut-off after last record, and automatic intermix (7", 10", or 12" records). The motor is of the heavy-duty, 4-pole induction type.

The second unit features the same type of tonearm and, in addition, includes an extra-heavy-duty 4-pole motor; heavy rim-weighted, balanced

turntable for flywheel action; 4 speeds plus manual switch for turntable action; and stereo muting switch. The "Conquest" is a popularly priced model with one-piece stereo tonearm. The turntable is driven by a heavy-duty, 4-pole induction motor, has 4 speeds with manual switch for turntable operation, and wow and flutter of 0.25% r.m.s. at 33⅓ rpm. The change cycle is 8 seconds, independent of record speed.

JANSZEN SPEAKER SYSTEM

Neshaminy Electronic Corporation, Easton Road, Neshaminy, Pa. is now offering its Z-300 system, a new unit in the "Jans-Zen" line of audio components.

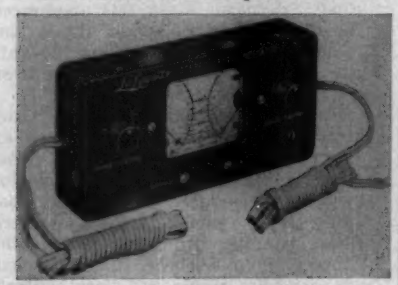


The new two-way system can be used in pairs for stereo reproduction or singly for monaural listening. The enclosure houses the company's electrostatic tweeter and a newly designed direct-radiator-cone woofer with the tweeter and woofer carefully matched. The tweeter utilizes two push-pull electrostatic radiators set in an arrangement to obtain maximum dispersion and broad sound source. The Model 350 woofer is an all-new design, 11" in diameter, properly baffled in a 2.2-cubic foot Fiberglas-filled enclosure. Its long voice-coil structure and flexible suspension make it possible to handle high power with low harmonic distortion. Transient distortion is avoided by use of a very light cone carefully controlled over its operating range and rolled off mechanically above 2000 cps rather than resorting to a crossover network.

The cabinet housing the system measures 28" high x 20" wide x 13" deep. It is available in rubbed mahogany, maple (birch), and walnut finishes with natural bouclé grille cloth.

STEREO BALANCE METER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. is now offering a new dual audio-output-level indicator, incorporating two independent well damped meter movements with scales calibrated in vu and per-cent.



The Model TM-40 has a separate continuously variable attenuator for up to 20 db of attenuation in each channel and a switch to permit calibrating one meter against the other.

Input impedance is 10,000 ohms per channel and sensitivity is 1.4 volts for zero vu. Blocking capacitors are internally installed to prevent meter damage by d.c.

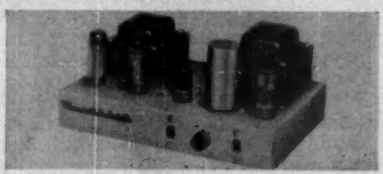
The damped meter movements respond to average values of music or speech voltage waveforms and are ideal for maintaining control of recording level on tape recorders or output level on stereo tuners, preamps, paging or music distribution amplifiers, or for comparing levels in any two audio channels.

The instrument is housed in a compact rectangular case and comes complete with leads.

12-WATT AMPLIFIER KIT

Heath Company of Benton Harbor, Mich. is now offering a new basic amplifier in kit form which is designed to be used as the second amplifier in a stereo system or as the only amplifier in a low-power audio setup.

The Model UA-1 uses 6BQ5/EL84 push-pull output tubes and has less than 2% harmonic distortion throughout the entire range (20 to 20,000 cps) at full 12-watt output. The "on-off" switches are located on the chassis and an octal plug is also provided to connect a preamplifier for remote control operation.



A specially designed output transformer provides good stability and low-frequency response while voltage feedback around the entire circuit reduces distortion. Taps for 4-, 8-, and 16-ohm speakers are provided. The 16-ohm tap features switch damping for unity or maximum.

An input level control makes this unit adaptable for use with wired music systems where a preamp is not required.

SCOTT STEREO AMPLIFIER

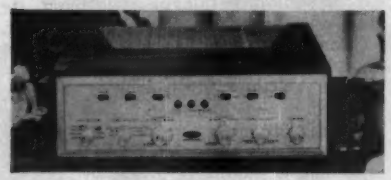
H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. has announced the development of a new stereo amplifier which consists of dual 20-watt power amplifiers and dual preamps on a single chassis.

The Model 299 can be used with any stereo or monaural source or as an electronic crossover. Its front-panel controls include a pickup selector switch for selection between two separate stereo phono pickups, scratch filter, rumble filter, loudness-volume control, input selector, function selector, separate treble and bass controls for channel A and channel B, stereo balance control, loudness control, and phase reversal switch. A unique indicator panel gives quick visual indication of operating mode.

When used with a stereo source, the Model 299 delivers 20 watts of power for each channel. On monaural pro-

gram sources the unit automatically uses the power for both sections, making it a 40-watt amplifier. There are special facilities for quick and accurate balancing of both channels.

There are two low-level stereo inputs and three high-level stereo inputs. The



preamp heaters are d.c. operated to eliminate hum. The self-balancing phase inverter stage automatically compensates for variation in output tubes due to aging. The d.c. bias and a.c. balance controls are included for laboratory adjustment of the amplifier.

For complete technical specs on the Model 299, write to Department P of the company.

TURNTABLES FOR STEREO

Rek-O-Kut, Inc., 38-19 108th St., Corona 68, N. Y. is now offering three new turntables which have been especially designed with the needs of the stereo disc user in mind.

The Model K-33 is a single-speed unit in kit form. It may be assembled in approximately 30 minutes without use of special tools. A 4-pole induction motor drives the turntable at 33⅓ rpm. The special endless woven fabric belt is held to a tolerance of ± .001 inch. There is a built-in strobe disc for checking speed. Noise level is −47 db.

The Model B-12GH is driven by a three-speed hysteresis synchronous motor and provides operation at 33⅓, 45, and 78 rpm. The 45 rpm hub is built-in and retractable. The turntable is of lathe-turned solid cast aluminum.

Model N-33H features a single-speed hysteresis synchronous motor with special braking for reduction of coasting. This turntable operates at 33⅓ rpm

and is belt-driven. Like the Model B-12GH, this unit includes a built-in strobe disc and has a noise level of −53 db.

All three of these "Rondine" turntables can be used with the company's S-120 monaural tonearm or its new stereo tonearms. A catalogue covering all of these turntables is available on request.

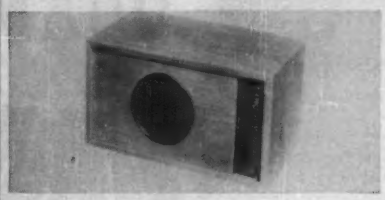
SMALL SPEAKERS FOR STEREO

Sonotone Corporation, Elmsford, N. Y. has developed a shelf-size speaker system which is designed to overcome

the problem of limited space confronting many audiophiles who are contemplating stereo set-ups.

A new 55 to 15,000 cps 8-inch speaker serves as the "heart" of the new system. Its wide range provides excellent stereo reproduction when teamed up with a quality primary system. The speaker unit is less than 11" deep and will fit comfortably on any standard bookshelf.

The WR-8 speaker uses a curvilinear cone and a special stiffening processing method which combine to prevent cone decoupling. Driving this cone is a



magnetic assembly which is larger than those normally found in speakers of this size.

Two models of the enclosure are currently available: the "Caprice" for a single WR-8 is only 20" wide, 11" high, and 10" deep. The "Mazurka" which is designed to accommodate two of the speakers measures 24" x 17½" x 10⅞". Standard acoustical construction with ¾" veneered plywood, screwed, glued, and re-inforced for maximum rigidity, plus Fiberglas lining for critical damping, insure distortion-free performance. The enclosures are available in mahogany, walnut, fruitwood, cherry, ebony, and blonde finishes.

AUDIO CATALOGUES

ORIGINS OF 45-45 DISC

The special "stereo issue" of the "Journal of the Audio Engineering Society," P. O. Box 12, Old Chelsea Station, New York 11, N. Y. contains an interesting and informative article describing the original conception of the 45-45 stereo disc in addition to other pertinent material on stereophonic reproduction.

Contributors to this issue include Dr. H. F. Olson of *RCA*, M. G. Crosby, P. W. Klipsch, among others. This issue of the "Journal," which is mailed free to AES members, can be purchased by non-members for $2.00 a copy. Send orders and payment direct to the Society at the address given.

OXFORD SPEAKERS

Oxford Components, Inc., 556 W. Monroe St., Chicago 6, Ill. has issued a two-color catalogue featuring its line of "Tempo" high-fidelity speakers.

Complete information and photographs are included on the firm's full-range speakers, its coaxial models, tweeters, woofers, and three-speaker system with crossover.

Copies of this catalogue will be supplied without charge on written request.

PICKERING STEREO BOOKLET

Pickering and Company, Inc., Sunnyside Blvd., Plainview, N. Y. is now offering free copies of a new booklet entitled "It Takes Two to Stereo."

Written by Walter O. Stanton, the new booklet describes the stereo disc and explains its operating principle. Twelve pages of information tell the hi-fi enthusiast what to expect and what to do to convert from a monaural to stereo system.

Diagrams and drawings illustrate the differences between conventional and stereo records—how they are recorded and reproduced.

The booklet is being offered free. It is available from the firm's dealers or from Dept. SB of the company direct.

FISHER BROCHURES

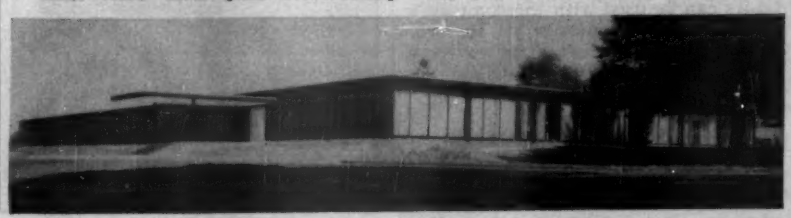
Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. has announced the availability of two brochures covering its new line of stereophonic and monaural consoles and components.

The radio-phonograph catalogue contains complete information and illustrations on nine new units: two stereo radio-phonographs complete in one cabinet, five units equipped with stereophonic controls and cartridges, a companion amplifier-speaker system, and a companion speaker system.

The component line folder offers a description of fourteen models. Included are the new stereophonic FM-AM tuner and the stereophonic master audio-control/duplex amplifier.

Either or both of these brochures will be supplied upon written request to the manufacturer. —30—

CBS Laboratories Research Center in Stamford, Conn. is now in operation following elaborate dedication ceremonies held in October. The glass-walled aluminum and steel structure, containing laboratory facilities for research and development in many areas of scientific activity, occupies a 23-acre site on High Ridge Road in Stamford. In addition to the working facilities at the new Research Center, the building contains a recreational area for employees and an open-air inner court. Clear glass floor-to-ceiling walls give a full view of the court.



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0Z4	3AU6	5W4GT	6BF5	6S8GT	7F8	12SA7	35/51
1A5GT	3AV6	5X4G	6BQ6G	6SA7	7G7	12SG7	35A5
1A7GT	3BA6	5X8	6BH6	6S8TY	7H7	12SJ7	35B5
1B3GT	3BC5	5Y3GT	6BH8	6SC7	7J7	12SK7	35C5
1C5GT	3BE6	5Y4G	6BJ6	6SF5	7K7	12SN7GT	35L6GT
1C6	3BN6	5Z3	6BK5	6SF765G7	7L7	12SQ7	35W4
1C7	3BU8	5Z4	6BK7	6SH7	7N7	12SR7	35Y4
1H4G	3BY6	6A8	6BL7GT	6SJ7	7Q7	12V6GT	35Z4GT
1H5GT	3BZ6	6AB4	6BN6	6SK7	7R7	12W6GT	35Z5GT
1L6	3C2	6AC7	6BQ6GT	6SL7GT	7S7	12X4	#37
1LA4	3C86	6AF4	6BQ7	6SN7GT	7V7	12Z3	#39/44
1LA6	3CF6	6AG5	6BR8	6SQ7	7W7	14A7	#41
1LB4	3CS6	6AG7	6BS8	6SR7	7X6	14AF7	#42
1LC5	3DT6	6AH4GT	6BY5G	6T4	7X7	14B6	#43
1LC6	3Q4	6AH6	6BZ6	6T8	7Y4	14F7	#45
1LH4	3Q5GT	6AK5	6BZ7	6U4GT	7Z4	14P8	#47
1LN5	3S4	6AK6	6C4	6U5	8AW8	14N7	50A5
1N5GT	3V4	6AL5	6C5	6U8	12A8	14N7	50B5
1P5GT	4BC8	6AL7GT	6C8G	6V3	12AB5	14Q7	50C5
1Q5GT	4BQ7A	6AM8	6CB6	6V6GT	12AQ5	1457	50C6G
1R5	4B58	6AN8	6CD6G	6W4GT	12AT6	17AX4GT	50L6GT
1S5	4BU8	6AQ5	6CF6	6W6GT	12AT7	17DQ6	50Y6
1T4	4BZ7	6AQ6	6CQ7	6X4	12AU6	19AU4	50Y7
1T5GT	4CB6	6AQ7GT	6CQ8	6X5GT	12AU7	19BG6G	#57
1U4	5AM8	6AR5	6CM8	6X8	12AV6	19C8	#58
1U5	5AN8	6AS5	6CL6	6Y6G	12AV7	19J6	#80
1V	5AQ5	6AS8	6CM6	7A4	12AX4GT	19T8	#81
1V2	5AS8	6AT6	6CM7	7A5	12AX7	19X8	117L7GT
1X2	5AT8	6AU4GT	6CN7	7A6	12AZ7	25AC5	117N7GT
2A3	5AV8	6AU5GT	6CU6	7A7	12B4	25AV5GT	117P7GT
2A5	5AW4	6AU6	6DG6	7A8	12BA6	25AX4GT	117Z3
2A7	5AZ4	6AU8	6DQ6	7B4	12BE6	25BK5	117Z4GT
2AF4A	5BK7	6AV5GT	6DT6	7B5	12BF6	25BQ6	117Z6GT
2B7	5BR8	6AV6	6E5	7B6	12BH7	25CD6G	807
2BN4	5BQ7	6AW8	6H6	7B7	12BK5	25CU6	9002
2D21	5BZ7	6AX4GT	6J4	7B8	12BQ6	25L6GT	9003
2E5	5CG8	6AX5GT	6J5	7C4	12BR7	25W4GT	9006
2X2A	5J6	6AZ8	6J6	7C5	12CA5	25Z5	
3A2	5T8	6BA6	6K6GT	7C6	12CU6	25Z6	
3A3	5U8	6BC5	6K7	7C7	12DQ6	#27	
3A4	5U4G	6BC8	6L6	7E6	12J5	#30	
3A5	5V4G	6BD6	6L7	7E7	12L6GT	#31	

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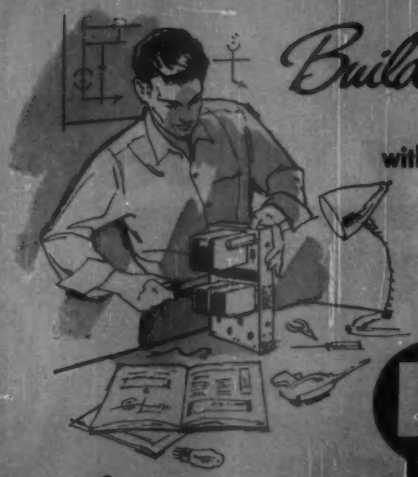

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In a class by itself—a control center that will do **anything** and **everything** you want. Features complete input flexibility—5 Stereo inputs (including tape heads), additional 4 inputs for monaural; all can be permanently connected and controlled from single switch. Six record equalizations for monaural; RIAA for Stereo. Volume, bass and treble controls on concentric shafts with special clutch for both individual channel and overall control. Single switch selects straight Stereo; Stereo Reverse, either channel separately, or either channel into monaural output. Continuously variable loudness control; cathode follower output and special recorder outputs; hum-free (DC on all tube filaments). Exclusive printed-circuit switches and boards. Custom-styled case, 4¼ x 13 x 8". Shpg. wt., 17½ lbs.

Model Y-776. Net only..... $62.50

Easy Terms: Only $6.25 Down

60-Watt Stereo Basic Amplifier Kit

Absolutely the finest dual amplifier you can build—equal to highest-priced factory-built units. Ideal for use with the KNIGHT-KIT preamp, either as two 30-watt stereo amplifiers or 60-watt monaural amplifier. Exceptional response from 10 cps to 42,000 cps. Phenomenal 0.08% distortion at full 60 watts. Includes static plate current balancing adjustments for each channel; absolute stability under all operating conditions; custom-quality transformers. Also has special built-in circuitry, with easy external adjustment, for precise balance of gain on each channel to achieve perfect monaural performance. Two printed-circuit boards for easy assembly. Beautiful black and chrome; 9 x 14 x 8¼". (Less cover.) 36 lbs.

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Deluxe FM-AM Hi-Fi Tuner Kit

The best-looking, best-performing FM-AM tuner kit for the money. You'll enjoy building it; you'll be proud of its performance and beauty. FM sensitivity is a remarkable **2.5 microvolts for 20 db of quieting. AM is 3 microvolts for 10 db signal-to-noise ratio.** Outstanding features include: single large printed-circuit board with most critical wiring already done; AFC (with disabling feature); flywheel tuning; precisely pre-aligned RF and IF coils—no further alignment needed; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; rotatable built-in AM antenna. Beautiful French-gray case, 4¼ x 13¼ x 8". Ready for interesting easy assembly. Shpg. wt., 12 lbs.

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EXCLUSIVE PRINTED CIRCUITRY

KNIGHT-KITS incorporate the latest technical advances; many include exclusive printed-circuit switches, as well as printed circuitry. You save time and you can't go wrong.

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KNIGHT-KIT hi-fi components, as easy to look at as they are to assemble, are professionally designed to take their place alongside the finest of home furnishings. You'll be proud of your finished work.

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Y-783. Attractive French-gray cover for above. 3 lbs. Net only..$3.95

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Universal Stereo Control Kit

Provides full centralized stereo control (volume, balance and channel selection) for use with any two amplifiers. Handles up to 20 watts program material. Unit simply connects between speakers and output terminals of amplifiers (no amplifier rewiring needed). Lets you balance speaker system volume; provides master gain control for overall volume (can be used remotely); lets you play either channel monaurally through one or both speakers; provides channel reversal; phase reversal switch for best overall performance. 4½ x 7¾ x 4". 3½ lbs.

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Every KNIGHT-KIT meets or exceeds published specifications, or we refund your money in full.

18-Watt Hi-Fi Amplifier Kit

Superb hi-fi specifications; deluxe custom styling. Includes 8 inputs for every desired signal source; full equalization; printed-circuit switches and boards for easy assembly. Shpg. wt., 15 lbs.

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Quality audio control center. 16 combinations of equalization; 8 inputs including tape head; DC on all tube filaments; printed-circuit switches and boards. Custom-styled. 12½ lbs.

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34-Watt Hi-Fi Amplifier Kit

Linear-deluxe Williamson-type circuit. Clear, rich 30 watts output; full equalization; 8 inputs; level and loudness controls; DC on filaments of preamp tubes; rumble filter; variable damping. Exclusive printed-circuit switches and boards. Custom-styled. 32 lbs.

Model Y-782. Net only **$74.95**

25-Watt Hi-Fi Basic Amplifier Kit

Williamson-type circuit. Response, ±0.5 db, 9-70,000 cps at half power. Includes balance control; calibrated damping control; potted output transformer. Shpg. wt., 25 lbs.

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Authentic Hi-Fi FM response. Includes AFC; flywheel tuning; pre-aligned RF and IF coils. 4 microvolt sensitivity guaranteed. Printed-circuit board for easy assembly. Custom-styled case. Shpg. wt., 12 lbs.

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2-Way "Ducted Port" Hi-Fi Speaker System Kit

Pre-finished enclosure; easy to assemble. Hi-fi response, 45-14,000 cps. Includes 12" woofer and horn-type tweeter. Available in mahogany, blonde or walnut (specify finish). 28 x 29 x 14". Shpg. wt., 33 lbs.

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Pre-finished enclosure, ready for quick assembly. Includes famous KNIGHT 3-way, 12" speaker. Response, 35-15,000 cps. Features "ducted port" for excellent bass response. Available in mahogany, blonde or walnut finish (specify). Shpg. wt., 47 lbs.

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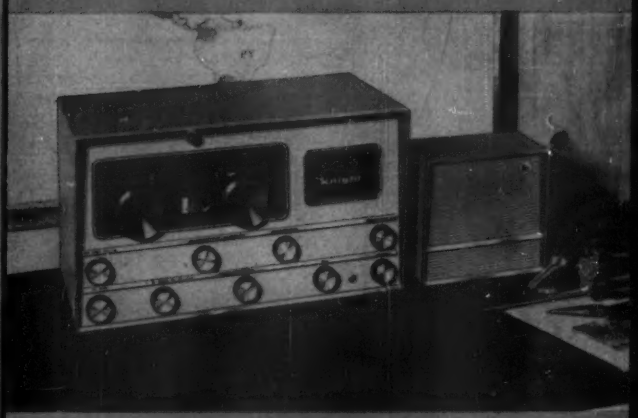

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IT'S THE BEST - BUILD IT YOURSELF AND SAVE!

Has all the selectivity, sensitivity and features of high-priced commercial units. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator; built-in Q-multiplier; delayed AVC; provision for Y-256 crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection for SSB. Controls: Main tuning, bandspread, band selector, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, ant. trim.—plus Q mult. controls: null-off-peak, selectivity, tune. Phone jack on front panel. Exclusive printed-circuit bandswitch; printed-circuit boards. Handsome metal cabinet, 10 x 10 x 16½", (Less speaker and S-meter.) 23 lbs. **$104.50**

Model Y-726. Net only . . . . . .

Easy Terms: Only $10.45 Down

Y-727. S-Meter Kit for above. 1 lb. Net. **$10.75**

Y-728. 4" speaker in matching cabinet. 3½ lbs. Net . . . **$7.50**

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Self-Powered VFO Kit

With built-in power supply. High stability; excellent keying; full TVI suppression. Planetary vernier drive. Calibrated for 80, 40, 20, 15 and 10 meters; output on 80 and 40 meters. Shpg. wt., 11 lbs.

Model Y-725. Net only **$29.50**

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Accurately measures SWR from 1 mc to 150 mc. Also measures antenna impedance. Has coax input and output. Invaluable for attaining peak antenna efficiency. Shpg. wt., 1½ lbs.

Model Y-253. Net only **$5.95**

100-kc Crystal Calibrator Kit

Crystal frequency standard for any receiver, at very low cost. Gives marker every 100 kc up to 32 mc. Trimmer for zero-beating with WWV. With crystal. Shpg. wt. 1 lb.

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Fascinating knight®-kits for Hobbyists

with exclusive "Convenience Engineering" for assured build-your-own success...

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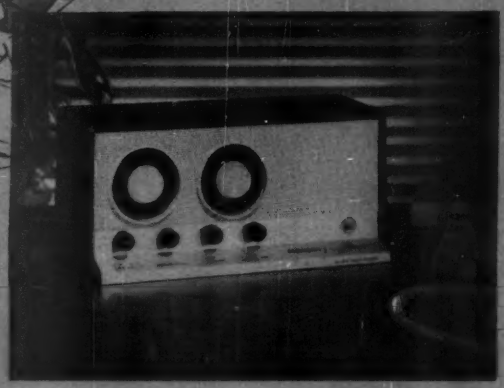

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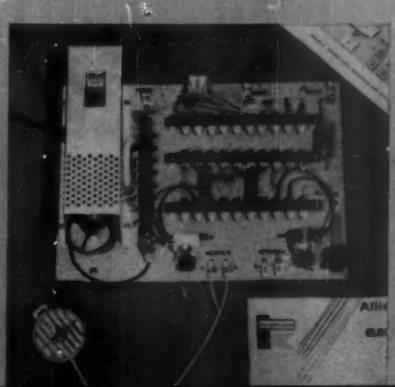

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Regenerative receiver for broadcast, long wave and short wave reception from 155 kc to 35 mc. With coil for broadcast band. For AC or DC. Shpg. wt., 7 lbs.
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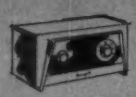

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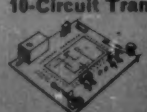

Builds any of 10 favorite projects. Entire kit on a printed circuit board. Just plug in leads to change from project to project. 3 lbs.
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1-Transistor Radio Kit

Offers fine local broadcast headphone reception. Printed circuit board for easy assembly. Works for months from penlight cell supplied. (Antenna and headphones required.) Shpg. wt., 1 lb.
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Excellent for local broadcast reception. Newest printed-circuit board for easy assembly. Built-in antenna; miniature dynamic earphone; plays for months from single battery. In handsome carrying case; only 4 x 3¾ x 1⅞". Less battery ($1.25). 1¼ lbs.
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Fast 1/700th-of-a-second flash; 50 watt/second output. Synchronizes with any camera with X or O shutter. Less battery. Shpg. wt., 4 lbs.
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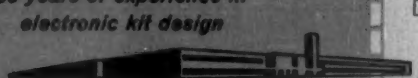

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New Tube Tester Data

If you own a Heathkit checker with an old chart, these listings of more recent tubes will help you.

HEATHKIT MODELS TC-1, TC-2 AND TC-2P

TUBE	TYPE	FIL.	PLATE	TOP	BOTTOM
1Z2	1	1.4	90	K	BEG
		(Good tube reads 30)			
2AF4	2	2	21	ABFG	DE
2B3	2	2	80	K	B
		(Good tube reads 10)			
2BN4	1	2	19	BEG	ADF
2CY5	3	2	22	AEF	BCG
2E26	3	6.3	21	CEK	ABDF
2E30	3	2.5	26	ABEF	CD
2T4	2	2	22	ABFG	DE
2V2	4	1.4	97	K	BDFGH
2X2(879)	4	2.5	52	K	D
2X2A	4	2.5	44	K	D
		(Good tube reads 40)			
3A2	4	2.5	54	K	ADFJ
3A3	4	2.5	75	K	G
3A4	2	1.4	26	BCDF	AG
3AF4	2	3.3	21	ABFG	DE
3B2	1	3.3	50	K	ACDEG
3BA6	2	2.5	23	ABEF	DG
3BC5	2	2.5	21	AEF	BCG
3BE6	2	2.5	21	A	BD
	2	2.5	21	EFG	BD
3BN4	1	2.5	19	BEG	ADF
3BN6	1	2.5	35	BEFG	AC
		(Good tube reads 20)			
3BU8	1	3.3	22	BCFG	AE
	1	3.3	22	BGHJ	AE
3BY6	2	3.3	25	AF	BD
	1	3.3	30	EG	BD
3BZ6	1	2.5	20	AEFG	BC
3CB6	2	2.5	21	AEFG	BC
3CE5	2	3.3	20	AEF	BDG
		(No open element test on lever E)			
3CF6	1	2.5	19	AEFG	BD
		(No open element test on levers E, G)			
3CS6	1	2.5	21	AF	BC
	1	2.5	25	EG	BC
3CY5	3	3.3	22	AEF	BCG
3DK6	3	3.3	22	AEF	BCG
3DT6	1	3.3	20	AEFG	BD
4BC5	1	5	18	AEF	BCG
4BC8	2	5	22	AB	CD
	2	5	22	FG	DH
4BE6	2	5	20	A	BD
	2	5	20	EFG	BD
4BN6	1	5	36	BEFG	AC
		(Good tube reads 23)			
4BS8	2	5	22	AB	CD
	2	5	22	FG	DH
4BU8	1	5	22	BCFG	AE
	1	5	22	BGHJ	AE
4CY5	3	5	22	AEF	BCG
5AM8	1	5	18	BCFJ	AD
		(No open element test on levers F, J)			
	1	5	18	H	DG
	2	5	22	FGH	EJ
5AN8		(No open element test on lever F)			
	2	5	23	AB	CE
5AQ5	3	5	27	AEFG	BD
5AS4	1	5	23	D	H
	1	5	23	F	H
5AS8	3	5	22	ABJ	CD
	2	5	24	F	DH
	2	5	21	AB	CE
5AT8	2	5	20	FGHJ	CE
		(No open element test on levers F, H)			
5AU4	3	5	30	F	H
	3	5	30	D	H
	2	5	22	FHJ	EG
5AV8		(No open element test on lever F)			
	2	5	23	BC	AE
5AW4	4	5	18	D	H
	4	5	18	F	H
5AX4GT	3	5	40	D	B
	3	5	40	F	H
5B8	2	5	21	BC	AE
	2	5	21	FHJ	ABCEG
		(No open element test on lever J)			
5BE8	2	5	20	AB	CE
	2	5	20	FGJ	CEH

Using "Tiny Tim" with a 25-watt horn type loudspeaker for outdoor activities. The amplifier is held on the lap and is plugged into the cigarette lighter socket.

"TINY TIM" PORTABLE P.A. AMPLIFIER

By **HAROLD REED**

Front view of the p.a. amplifier in its cabinet. After installing the power transistors on the heat sink plate, it is wise to check between the transistor cases and the plate with an ohmmeter to make certain that there is no short.

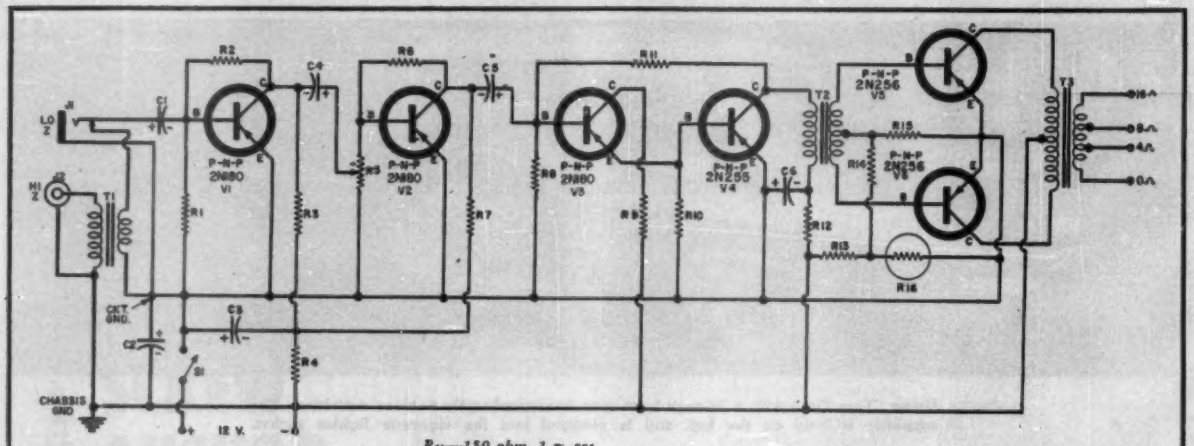
Compact transistorized sound system can be powered directly from your car's cigarette lighter socket.

FOR many years sound re-inforcing systems have been used in numerous ways, both inside and out of doors. There are the large permanent installations, portable type equipment, and mobile setups. Power ratings also vary over a considerable range, from a few watts to many watts of power output.

Those engaged in commercial public-address work often need high-power systems, but the electronic experimenter and audio hobbyist are more likely to require a sound system ranging from a few to about 10 watts' output. Even within this range of power, systems employing tubes are relatively large and heavy. For one thing, the power supply for such a system contributes considerably to the weight and size and, if it is to be operated where 117-volt a.c. is unavailable, a vibrator or rotary converter type of power supply must be carried along with the rest of the equipment.

A transistorized sound system overcomes these disadvantages both as to weight and size and may be operated directly from an automobile battery without the need for a power converter.

The "Tiny Tim" circuit is shown in Fig. 1. It incorporates two inputs, one for high-impedance crystal or ceramic microphones and the other for low-impedance dynamic types. The high-impedance input works into transformer T_1, which is connected to the first transistor V_1, a *p-n-p* junction type, through capacitor C_1. T_1 has a primary impedance of 200,000 ohms and secondary impedance of 1000 ohms, which is suitable for working between a high-impedance transducer and the base input of a transistor. The low-impedance input circuit bypasses the input transformer and is fed directly to the base of V_1 through coupling capacitor C_2. The 3-circuit input jack automatically opens the transformer secondary connection when the low-impedance microphone plug is inserted. The output of the first transistor stage works into the gain-control potentiometer R_5. After the gain control are two more *p-n-p* amplifying stages, V_2 and V_3, followed by a *CBS*-2N255 transistor, the output of which is connected to transformer T_2. This transformer has a primary impedance of 100 ohms and the secondary impedance is 200 ohms with a center-tap. Transformer T_2 is the driver transformer for the push-pull, class B output stage consisting of *CBS*-2N256 transistors V_5 and V_6. The output transformer T_3 is a 10-watt "universal" type designed especially for transistor amplifiers. The primary impedance should be from 24 to 32 ohms. The secondary is tapped at 4, 8, and 16 ohms for speaker matching.



R_1—12,000 ohm, ½ w. res.
R_2—100,000 ohm, ½ w. res.
R_3—22,000 ohm, ½ w. res.
R_4—2200 ohm, 1 w. res.
R_5—10,000 ohm miniature pot (Lafayette Radio VC-34)
R_6—180,000 ohm, ½ w. res.
R_7—6800 ohm, ½ w. res.
R_8—3300 ohm, ½ w. res.
R_9—1000 ohm, ½ w. res.
R_{10}—270 ohm, ½ w. res.
R_{11}—47,000 ohm, ½ w. res.
R_{12}—47 ohm, 1 w. res.
R_{13}—150 ohm, 1 w. res.
R_{14}—100 ohm, 1 w. res.
R_{15}—3.3 ohm, ½ w. res.
R_{16}—130 ohm, washer-type thermistor (Veco #21W1, Victory Engineering Corp.)
C_1—2 μfd., 6 v. elec. capacitor
C_2—500 μfd., 25 v. elec. capacitor
C_3—160 μfd., 25 v. elec. capacitor
C_4, C_5—2 μfd., 15 v. elec. capacitor
C_6—25 μfd., 25 v. elec. capacitor
T_1—Input trans. 200,000 ohms to 1000 ohms, center-tapped (Argonne, AR-100)
T_2—Input trans. 100 ohms to 200 ohms, center-tapped (Argonne AR-304)
T_3—"Universal" output trans. 10 watts push-pull, pri. tapped 24-32 ohms, sec. tapped 4, 8, 16 ohm v.c. (Lafayette TR-94)
J_1—Three-circuit jack
J_2—Microphone connector (Amphenol)
S_1—S.p.s.t. switch ("Power," see text)
1—4" x 5" x 6" metal cabinet with chassis plate (Bud C-1796)
V_1, V_2, V_3—"p-n-p" junction transistor (2N180, 2N107, or CK722, see text)
V_4—"p-n-p" power transistor (CBS-2N255)
V_5, V_6—"p-n-p" power transistor (CBS-2N256)

Complete schematic and parts listing for the portable p.a. amplifier. Note the use of stabilizing thermistor R_{16}.

The first three stages, V_1, V_2, V_3, may be *CBS* transistors, type 2N180 with a rated *beta* of 60. With these transistors a power output of 10 watts can be obtained. Less expensive, lower gain types such as the 2N107 and CK722 may be employed if the builder is willing to settle for lower output.

Designing the output stage for class B service provides most efficient operation. It results in maximum power output from a pair of transistors. The power demand is lower since the output current is very small when there is no audio signal applied to the amplifier input. This is very important when working with battery-operated devices. At full 10 watts output, current drain will be over 1.5 amperes.

The circuit, except for some modifications, is similar to one suggested by *CBS* for its 2N256 transistors in class B service.

A thermistor, R_{16}, is used in the output stage. It provides protection when the transistors are subjected to high operating temperatures. The temperature change affecting the thermistor may arise externally or may be the result of current flow through it. In either case, its resistance varies. This automatically adjusts the transistor bias current as operating conditions vary.

Construction Data

As can be seen in the photographs, the amplifier is assembled in a 4" x 5" x 6" metal cabinet. A 3⅞" x 4⅛" steel chassis plate, which is included with the cabinet, is welded to the rear of the front panel. This plate was used, not only for mounting the parts but for the shielding it provides between the input and output sections of the compact transistorized amplifier.

One great advantage with transistor circuitry is the absence of 60-cycle hum induction in low-level input circuits since no a.c. filament supply is required. In this unit, care must be exercised in placing the transformers because they are housed in such a small area. To prevent unwanted coupling effects, the transformers are oriented with respect to each other to keep inter-coupling to a minimum. This arrangement can be seen in the rear-view photo. This precaution, together with the shielding afforded by the chassis plate, resulted in a stable amplifier.

The first three transistors and most of the other small component parts are wired to a perforated, 2" x 2¾" Bakelite board equipped with solder terminals. The board and terminals shown in the photo are of a type used in commercial devices but the constructor can assemble a similar terminal plate with the boards and flea clips sold by *Lafayette Radio*. Because of their long life, the small transistors were wired directly to the terminals instead of using sockets.

A miniature 7-pin tube socket is attached to the chassis plate of the cabinet and the 2N255 driver transistor for the output stage is plugged into pins 1 and 5 of this socket. A 1¼" x 2¼" x ⅛" piece of Bakelite is placed on the opposite side of the chassis from the socket and countersunk, flat-head machine screws hold the socket and piece of Bakelite to the chassis. Two holes, tapped for 4-36 machine screws, are provided in the Bakelite strip and these screws pass through the transistor flange and hold the assembly in place. Two holes are drilled in the Bakelite piece directly over pins 1 and 5 for passage of the emitter and base pins into the socket. This arrangement secures the transistor firmly in place but keeps its case from making contact with the metal chassis. The case, base, and emitter pins must not touch the chassis.

The *"Veco"* thermistor, which is a washer-type made by *Victory Engineering Corporation*, is mounted on a small bracket which is attached to the chassis plate. Shoulder and flat fiber washers are used to insulate the thermistor from the metal bracket and solder lugs are placed next to the contact surfaces of the thermistor for electrical connection. Care should be used in mounting the thermistor. These washer-types are easily broken.

The power and output binding posts and microphone jack are insulated from the front panel by fiber shoulder washers. It should be noted that the circuit ground is not connected directly to the metal cabinet. All connections to this ground point are taken to one terminal of a three-terminal stand-off strip mounted on the chassis. This point is then bypassed to chassis ground and the negative side of the d.c. supply by the 500 μfd. capacitor, C_2. The chassis ground point is taken to the center terminal of this strip.

Power transistors run hot at 10 watts' output. The two power output transistors are, therefore, mounted outside of the cabinet to obtain maximum ventilation. This was arranged by attaching two 7-pin miniature tube sockets to the top of the cabinet. These are the bottom-mounting type of socket without shield flange. A 3¾" x 5⅞" x ⅛" aluminum plate, or

heat sink, is placed over these sockets and is insulated and spaced from the cabinet by means of fiber shoulder and flat washers. Holes are drilled through the plate directly over pins 1 and 5 of the sockets to allow passage of the transistor base and emitter pins which plug into pins 1 and 5 of the sockets. The transistor pins must not touch the plate. Two holes, tapped for 4-36 machine screws, are provided in the plate to secure the transistor cases. A small piece of spaghetti tubing is placed over the screws where they go through the cases and flat fiber washers are used under the heads. Very thin mica is placed under the transistor cases to completely insulate them from the heat sink plate.

A solder lug is placed under one of the mounting screws to provide connection to the transistor collectors which are internally connected to the transistor case. The leads for the collectors are taken through small holes in the plate, through the center holes in the tube sockets, and soldered to terminal 3 of the sockets. Wires of suitable length are soldered to base, emitter, and collector terminals of the sockets and these are connected to appropriate tie points on the chassis plate just before the unit is placed in the cabinet. Since maintenance of the device is nil, this is no inconvenience and, even so, the panel and chassis can still be pulled far enough out of the cabinet to make tests, if necessary.

A carrying handle is attached to the aluminum plate. This heat sink need not be aluminum. It may be other metal, but it is desirable to use a plate at least ⅛-inch thick for good heat dissipation. Two ventilating louvres are used, one in each end of the cabinet, to provide air circulation although this is probably unnecessary. The 2N255 transistor is "just coasting." Rubber feet are mounted to the bottom of the cabinet. A 6-foot power supply cord with tinned leads on one end for connection to the amplifier binding posts and a connector on the other end for plugging into the cigarette lighter socket is used for obtaining the 12-volt d.c. potential required for the unit.

Although the unterminated, tinned leads of the power cord should present no problem if the amplifier is used only by the constructor, it was realized after the device was completed, that if other persons use the equipment it would be desirable to provide suitable connectors on the amplifier and power cord, since individuals not familiar with the problem may plug the cord into the cigarette lighter socket first and then short out the open tinned leads on the other end.

Except for the two output transistors, all parts are mounted either on the front panel or chassis. A power switch is included on the panel. The front panel was laid out, not with good looks in mind, but for convenience in operating the device. With all connections at the front, the unit may be set upright on a table or laid down on an auto seat, the car floor, or on the ground.

Operating Procedure

Setting up the "Tiny Tim" p.a. system is very simple. Select the proper output terminals to match the loudspeaker impedance, that is, 4, 8, or 16 ohms. More than one speaker may be used. For instance, two 8-ohm speakers could be connected in parallel across the 4-ohm output. Likewise, two 4-ohm speakers may be connected in series across the 8-ohm output terminals. The power cord is connected to the terminals marked "12 volts" and the cigarette lighter plug is inserted in the lighter socket in place of the cigarette lighter. It is extremely important that the plus and minus polarities from the battery correspondingly connect to the plus and minus binding posts on the amplifier panel. If in doubt, check polarity at the ends of the cord with a d.c. voltmeter with the lighter plug inserted before connecting the tinned leads to the amplifier terminals. When the leads are identified, it is wise to dab some red paint on the one that is to connect to the plus terminal. The transistors can be permanently damaged if battery polarity is incorrect.

Turn the gain control all the way down and plug in the microphone. High-impedance microphones are to be connected to the bottom *Amphenol* connector and low-impedance microphones should be plugged into the phone jack immediately above. Throw the power switch on. Bring the gain control up slowly and speak into the microphone. Adjust the gain control for the desired volume level.

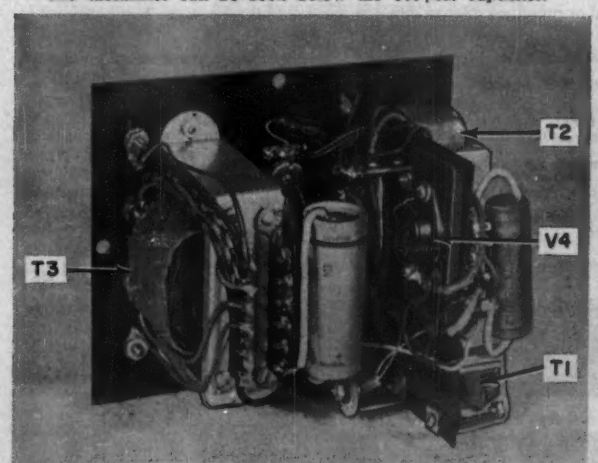
As is the case with all sound reinforcing systems, if the microphone is used close to the loudspeaker, acoustic feedback will occur, causing a "howling" condition when the gain control is advanced beyond a certain point. The farther away the microphone is from the speaker, the higher the gain control can be set without causing feedback. Also, the loudspeaker should be turned away from the microphone.

Current drain is low with no audio signal at the amplifier input and, since no warm-up time is required, the power switch may be kept off except when the unit is actually in use. An added feature would be to connect a "push-to-talk" switch across the main power switch, then with the main switch off, the amplifier could be operated intermittently with the push switch.

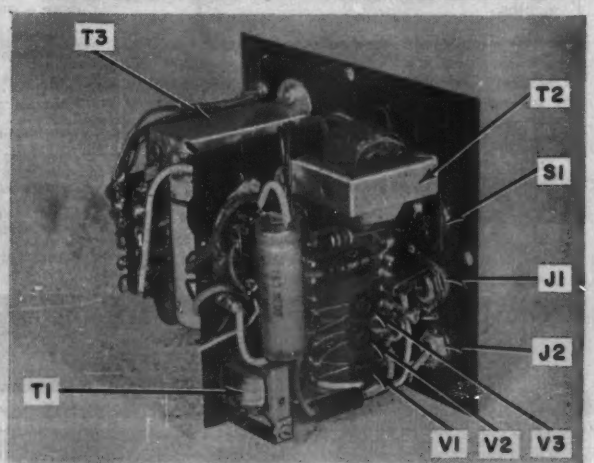
Although "Tiny Tim" was built for portable/mobile use with battery supply, it can serve in a fixed installation and powered with any type supply capable of meeting the necessary voltage and current requirements.

Other transistor types may, of course, be employed. Care should be taken not to exceed their power ratings and, if *n-p-n* types are used, the battery potential polarities must be reversed. In addition, all electrolytic capacitor connections would have to be transposed in such a case. —30—

Rear view of the amplifier. Terminal strips are soldered to the top of the output transformer for lead connections. This is not necessary but is handy for experimental work. The thermistor can be seen below the 500-μfd. capacitor.



Here is another view of the unit. This one shows the layout of the input section. The three small transistors are soldered directly to the terminals on the Bakelite board. The socket for the 2N255 power transistor can also be seen.



SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

Model TW-11 — TUBE TESTER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

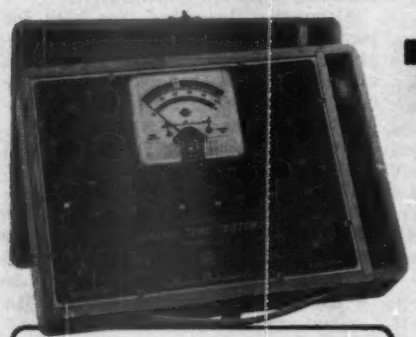
The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50 NET

SUPERIOR'S NEW MODEL 82

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!



① Turn the filament selector switch to position specified. ② Insert tube into a numbered socket as designated on our chart (over 600 types included). ③ Press down the quality button —

***THAT'S ALL!* Read emission quality direct on bad-good meter scale.**

Model 82 — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82 will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82 the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any indicates automatically.

- Tests over 600 tube types.
- Tests 0Z4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82 comes complete, housed in portable, hand-rubbed oak cabinet with removable cover. Only

$36.50 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See page 105 for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates

ALL PICTURE TUBES

Model 83 — C.R.T. TUBE TESTER . . . Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months.

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—
in the carton—
out of the carton—in the set!

The Problem:

Required, a tester—housed in a single carrying case capable of testing and rejuvenating *all* picture tubes including black and white and color; 50 degree, 90 degree or 110 degree. A tester capable of testing these ever increasing types speedily and efficiently. A tester capable of proving to the satisfaction of the set owner that the picture tube is definitely good, bad or weak. To do so the serviceman must be able to instantly switch from the comparative simple testing of a black and white tube to the complex requirements for testing each individual section in a tri-gun color tube.

The Solution:

The Model 83 more than meets the requirements specified above. It will not only test every type of picture tube ever made but will test them for leakage, emission and gas content. Furthermore even if the tube tests "good" Model 83 will help you to predict the length of time the tube will remain "good." The Model 83 will also enable you to extend the useful life of a "weak" tube by *properly controlled* application of rejuvenating voltage.

Specifications:

- Model 83 is *not* simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only ——— **$38.50**

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Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See page 105 for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77 — VACUUM TUBE VOLTMETER... Total Price $42.50 — Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 1006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to +18 db, +10 db to +38 db, +30 db to +58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only

$42.50 NET

SUPERIOR'S NEW MODEL 79

The Most Versatile All-Purpose Multi-Range Tester Ever Designed!

SUPER-METER

WITH NEW 6" FULL-VIEW METER

A Combination **VOLT-OHM MILLIAMMETER.**
Plus **CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.**
Also Tests **SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES**

Model 79 — SUPER-METER . . . Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months.

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: 001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads.....Only

$38.50 NET

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Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See following page for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!

√ R.F. Signal Generator for A.M.
√ R.F. Signal Generator for F.M.
√ Audio Frequency Generator
√ Bar Generator
√ Cross Hatch Generator
√ Color Dot Pattern Generator
√ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Model TV-50A GENOMETER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months.

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

The Model TV-50A comes complete with shielded leads and operating instructions. Only

$47.50 NET

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

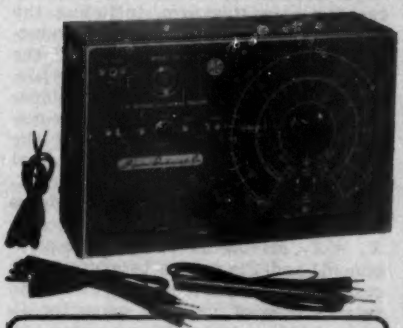
DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 263.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency).

For the first time ever: ONE TESTER PROVIDES ALL THE SERVICES LISTED BELOW!

SUPERIOR'S NEW MODEL 76

ALL PURPOSE BRIDGE



Model 76 . . . Total Price $26.95 — Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months.

IT'S A

CONDENSER BRIDGE

with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A

RESISTANCE BRIDGE

with a range of 100 ohms to 5 megohms

IT'S A

SIGNAL TRACER

which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A

TV ANTENNA TESTER

The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

CAPACITY BRIDGE SECTION

4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

RESISTANCE BRIDGE SECTION

2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

SIGNAL TRACER SECTION

With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

TV ANTENNA TESTER SECTION

Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna. . so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

$26.95 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C. O. D.

MOSS ELECTRONIC, INC.
Dept. D-541 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

Name .....

Address .....

City ..... Zone..... State.....

All prices net, F.O.B., N. Y. C.

- ☐ **Model TW-11** ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ **Model 85** ..... Total Price $36.50
  $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 83** ..... Total Price $33.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 77** ..... Total Price $42.50
  $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 79** ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model TV-50A** ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ **Model 76** ..... Total Price $26.95
  $6.95 within 10 days. Balance $5.00 monthly for 4 months.

Measure That Flutter

(*Continued from page 61*)

of the existing flutter, which is usually expressed as a percentage. One method that will give an idea of the per-cent flutter is as follows.

Record a 3500-cycle signal from the oscillator and play back this tape to the flutter tester. Adjust for minimum reading on the null meter. Remove the recorder output from the tester and connect the oscillator in its input. Adjust the oscillator output control to obtain the same signal voltage to the tester as existed when the tape was played. Vary the frequency of the oscillator to again obtain lowest reading of the null meter. Do not change the balance controls. Note the oscillator frequency which gives this null indication. Now we can learn something about the flutter. If the deviation frequency is found to be higher than the fundamental frequency, then, *Per-cent Flutter* = $[(f_2 - f_m)/f_m]$ 100, where f_m is the mid, or fundamental, frequency and f_2 the deviation frequency. When the deviation frequency is found to be lower than the mid-frequency, then: *Per-cent Flutter* = $[(f_m - f_1)/f_m]$ 100, where f_1 again represents the deviation frequency.

Consider the following examples. f_m = 3500 cycles, f_2 = 3570 cycles. Then, [(3570 −3500)/3500] 100 = 2% flutter. Also, if f_1 = 3430 cycles then, [(3500−3430)/3500] 100 = 2% flutter. Thus we may term these two results as ±2% flutter which is actually the percentage change from the mid-frequency.

Two per-cent would represent a considerable amount of flutter since present-day recorders have flutter percentages somewhat below 1%. It is interesting to note that the author, when checking flutter as just explained, found one of the earlier model machines had 2% flutter, whereas a late model unit costing $50.00 less than the older unit, had only 0.3% flutter. This indicates the great advances that have been made in tape transport mechanisms. Of course, the old model may have done better with new parts but since they were not badly worn it probably would not have done better than about 1½%.

The flutter tester could be equipped with a self-contained a.c. meter and calibrated in the manner just outlined where the 2% flutter point was found. Meter scale markings would be from 0 to 2%. Accuracy will depend on how the constructor interprets the frequency of his oscillator for each setting.

A d.p.d.t. switch may be used to connect the meter to the bridge null connections or to the input of the bridge to calibrate the meter before making a flutter check. The meter would include a "CAL" marking on its scale and the input level would be adjusted so the meter would deflect to this mark when switched to the bridge input.

A preferred method for calibrating the tester, if the builder is in a position to do so, is to calibrate the device against a laboratory-type flutter indicator.

This section is included for the benefit of the reader interested in designing his own filter and bridge circuits.

The following terms and equations apply to the bandpass network. The term f_1 represents the low cut-off frequency while f_2 is used to indicate the high cut-off frequency. The geometric mean, or mid-frequency, of f_1 and f_2 is f_m. Therefore $f_m = \sqrt{f_1 f_2}$. Bandwidth of the circuit is $(f_2 - f_1)/f_m$. The characteristic impedance is symbolized by R.

The inductance of L_1, in Fig. 1, is then found from the equation $L_1 = R/\pi(f_2 - f_1)$ where f_1 and f_2 are in cycles per second, R is in ohms, and L is in henrys.

The capacitance of C_1, in Fig. 1, is given by $C_1 = (f_2 - f_1)/(4\pi f_1^2 R)$ and the value of C_2 is found by solving the equation $C_2 = 1/\pi(f_1 + f_2)R$ where C is in farads.

In the bandpass filter network of the complete circuit of Fig. 3, the values chosen were f_m = 3500 cycles, f_1 = 3248 cycles, f_2 = 3773 cycles, bandwidth 0.15, and R = 1000 ohms.

Mathematical data for the resonance bridge circuit of Fig. 2 is as follows: When the four arms of the bridge are purely resistive, then the bridge can be balanced, when $R_3/R_2 = R_5/R_4$. Also $R_2 = (R_1/R_3)R_4$, where R_3 is the total resistance in this arm, including the series resistance of L. Now the inductive reactance is $X_L = 2\pi fL$ and the capacitive reactance is $X_c = 1/(2\pi fC)$. In Fig. 3, L_3 and the parallel combination of $C_3 - C_7 - C_8$ form the series-resonant circuit and the values of the component parts were chosen so that resonance occurs at the mid-frequency, f_m, previously selected for the bandpass filter with ½ of C_3. At this frequency, $X_L = X_c$, leaving only a resistive component, and the bridge balances. This resonant condition is obtained with the rotor plates of variable capacitor C_8 about half meshed. The capacitor will actually tune the resonant circuit from 3400 to 3600 cycles—which is 2.86% above and below f_m. —30—

CONSTANT GENERATOR OUTPUT FOR IMPROVED SCOPE SYNC

By CHARLES ERWIN COHN

AUDIO oscillators, square-wave generators, etc. bring their outputs out through attenuators. It is a good idea to add an auxiliary output jack on such instruments, connected to a point on the instrument ahead of the attenuators so that it would have constant output signal irrespective of attenuator setting.

The utility of this extra jack becomes apparent when the generator is used in conjunction with an oscilloscope. The extra jack can be connected to the external sync jack on the scope and used to provide a sync signal. Thus, when the attenuator is varied during testing at one frequency, the oscilloscope synchronization will be undisturbed.

In most popular audio generator kits, the place to connect this jack is at the high side of the output level pot. —30—

Phone of the Future

(*Continued from page 45*)

clipped sine wave with a peak-to-peak value of about 100 microamperes. This is of a constant-current nature and is coupled to the frequency-selective network. This network is the same one shown in Fig. 1, as the "Party" coil and capacitors. It can be connected to respond to any one of eight different frequencies, so that the sound radiator will respond only to its own call on an eight-party line depending on the frequency which is sent out from the central office.

As in the case of the digit frequencies, the problem of "talk-off" could be present in this type of a circuit. For example, when people started to talk some of the voice frequencies might come out of the loudspeaker not only in the customer's own telephone but on all the others on the line as well.

To prevent this, a silicon diode is placed in series with the sound radiator and the amplifier which drives it. This diode is of the type which has an avalanche breakdown voltage of 24 volts; that is, it will not conduct unless there is a potential of 24 volts across it. When no one is talking on the line, this voltage will be available from the 35 to 50 volts direct current which is normally on the line, so under these conditions it will be possible to sound the speaker. However, once a telephone is taken off the hook, the current flow through the transmitter will drop this voltage to a point well below 24 volts, which effectively opens the path to the sound radiator.

The push-button telephone is not in service as yet, in fact it is only an experimental device. However, the tone radiator is already a reality and is now undergoing field trials.

It is interesting to note that the size of a loudspeaker which can be concealed in the base of a telephone automatically puts it in the tweeter class and the frequencies which would radiate most efficiently from it might sound shrill to the user. However, frequencies may be used which are harmonics of a lower frequency, which is below the ability of the speaker to reproduce. A quirk of the human ear is that when it hears these higher harmonics it automatically supplies the missing fundamental. Therefore, the customer may hear a pleasing tone which does not exist! —30—

"This one?"

What's New in Radio

DELUXE HAM RECEIVER

The National Company, Inc. of Malden, Mass. has recently introduced a deluxe amateur-band receiver, the Model NC-303.

The new unit covers all amateur bands from 1¼ to 160 meters with WWV coverage available by means of

an accessory converter. A five-position i.f. selector provides sharp, SSB-1, SSB-2, medium, and broad selectivity. Bandwidths of .5, 2, 4, and 8 kc. provide optimum selectivity for SSB, c.w., phone, phone net, and v.h.f. plus sideband selection. A tone switch provides attenuation of highs, lows, or both for maximum readability. There is a separate automatic noise limiter for AM and a double-ended manual limiter for c.w. and SSB. A fine-tuning vernier dial drive provides precision c.w. and SSB tuning. The high-speed 40:1 tuning dial includes a logging scale.

A data sheet covering this new addition to the firm's line of equipment for the radio amateur is available without charge from the company.

RECTIFIER ADAPTER KIT

International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. is in production on an all-purpose replacement kit which is designed to eliminate the necessity for service technicians to carry two or three styles of 500-ma., 130-volt silicon diodes.

The SD-500 kit offers the technician a fast, simplified means of replacing all existing radio-TV silicon rectifier types. It contains a hermetically sealed, pigtail-style diode which may be wired in to replace axial-lead-type units or plugged into existing fuse-clip-type sockets in a rapid 10-second conversion.

Designed specifically for replacement applications, the new silicon junction rectifier can operate at 100 degrees C ambient with resistive, inductive, or capacitive load and can supply full-rated power under normal convection cooling with no external heat sink required. The SD-500 may also replace existing selenium rectifier types or if a direct mechanical replacement is required, the firm's "Unistac" TV-500 may be used with no conversion required.

The company's authorized distributors have this new unit in stock.

TRANSISTOR-RADIO TESTER

The Hickok Electrical Instrument Company, 10524 Dupont Ave., Cleveland 8, Ohio has developed a new "Traceometer" which has been designed specifically for troubleshooting and servicing transistorized portables and auto radios.

The Model 810 is actually three instruments in one: a tuned receiver, AM signal generator, and transistor tester. The tuned receiver provides 200-575 kc. for troubleshooting i.f. stages, 550-1600 kc. for troubleshooting the r.f. stages, an audio amplifier for signal-tracing the audio stages, and a low-impedance 400-cycle audio output for signal injection.

The signal generator portion of the instrument covers 200-575 kc. for i.f. alignment and 500-1600 kc. for r.f. alignment. A cathode-follower input probe is included.

The transistor tester circuit checks leakage and gain. A built-in loudspeaker is used as the indicator for signal tracing.

Model 810 is housed in a portable steel case which measures 11¼" wide, 9" high, and 7" deep. It will operate from 105-125 volt, 50-70 cycle a.c. sources. Additional information on this new unit will be supplied on request.

ZENER REGULATORS

The Semiconductor Division of *Hoffman Electronics Corporation*, 3761 S. Hill St., Los Angeles 7, Calif., has announced the development of a diversified line of silicon diffused junction zener power voltage regulators which embraces 114 type and size combinations.

The line consists of 38 types in each of three power categories (¼ watt, 1 watt, and 10 watts). The line was developed for circuit applications requiring higher power than can be obtained with conventional zener diodes and where temperature stability does not call for a closely compensated reference device.

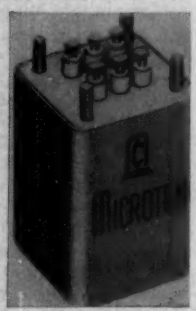
The zener voltage in each power rating ranges from 5.6 volts through 200 volts in 10% voltage steps. The units

are offered in ±10% zener voltage tolerance and ±5%, up to 56 volts. Dynamic impedance ranges from 1400 ohms for the 200-volt, ½-watt zener regulator type down to 1 ohm for the 5.6-volt, 10-watt unit. Test current varies from 1 ma. up to 1000 ma.

Technical Bulletin No. 30-58, available from the manufacturer, supplies detailed data on the line.

D.C.-TO-D.C. TRANSFORMERS

Microtran Company, Inc., 145 E. Mineola Ave., Valley Stream, N. Y. is now offering a series of d.c.-to-d.c. converter transformers.



These new units permit conversion of low-voltage direct current to high voltage for operating mobile and military electronic equipment. These miniaturized, high-efficiency transformers when used in transistor switching circuits provide improved reliability, efficiency, and ruggedness.

All transformers are hermetically sealed and constructed in accordance with MIL-T-27A, Grade 4, Class R, 10,000-hour minimum life specs. Input voltage range is 13.6 to 28 volts d.c. with output ranging from 125 to 500 volts d.c. Full-wave and CT loads may be drawn simultaneously. Output voltage to input of the rectifier is a 1600-cycle nominal square wave permitting ease of filtering.

The transformers are now available as stock items from the firm's distributors.

NEW "HANDIE-TALKIES"

The Communications and Industrial Electronics Division of *Motorola Inc.*, 4501 W. Augusta Blvd., Chicago 51, Ill.

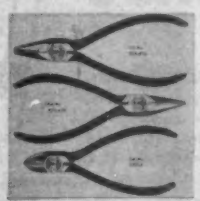
has announced the field-testing of a new "Handle-Talkie" pocket receiver and its companion pocket transmitter for service in the 25-54 mc. and 144-174 mc. bands.

The fully transistorized receiver utilizes 17 transistors and 5 diodes. The antenna is built-in but may be supplemented by a plug-in external antenna for maximum range. The use of semiconductors also contributes to the low power drain characteristics and high reliability standards of the receiver. Modular printed circuits make up the entire inner chassis which is shock mounted on a rubber cushion in the shatterproof plastic case. The unit is powered by mercury cells or rechargeable nickel-cadmium cells. The receiver weighs 10½ to 12 ounces, depending on the battery used. It measures less than 6" long, 2½" wide, and 1⅛" deep.

The 46-ounce transmitter measures approximately 8" x 4" x 1½" and provides a full 1¼ watt r.f. output on the 25-54 mc. band and 1 watt in the 144-174 mc. band.

MIDGET PLIERS

Mathias Klein & Sons, 7200 McCormick Road, Chicago 45, Ill. is introducing a new line of midget pliers which has been especially designed for the wiring and servicing of delicate electronic equipment.



These pliers measure from 4" to 4½" long and in all respects are the equals of the firm's standard line of tools. Four models are available: 257-4 oblique cutting plier, 321-4½ long-nose plier, 322-4½ long-nose plier with knurl, and 224-4½ end-cutting plier. All of the models are available with coil spring to keep jaws open and may be had with plastic-dipped handles if desired.

Bulletin 758 describing the new line in detail is available without charge upon written request to the manufacturer.

"UNIVERSAL BASE" ELECTROLYTIC

Sprague Products Co., 51 Marshall St., North Adams, Mass. has developed a new "universal base" electrolytic in its "Print-Lok" line of capacitors.

The base of the new type component is designed to fit all sets using printed wiring boards. A pair of pliers is all that is needed to adapt these capacitors to any one of three different types of printed circuit bases. They can also be used to replace standard twist-base electrolytics.

The capacitors are hermetically sealed in aluminum cases to give extra long life and dependable performance. Complete ratings for these new units are given in the company's recently published "TV Electrolytic Capacitor Replacement Guide," K-103. Free copies are available from the company's distributors or by sending 10 cents in coin to the company direct.

2- AND 4-SET COUPLERS

Blonder-Tongue Laboratories, 9 Alling St., Newark, N. J. has announced the availability of a new series of 300-ohm TV and FM installation accessories.

Marketed as "Exact-Match" TV couplers, the units feature newly developed, patented circuitry which provides maximum signal transfer, maximum isolation between receivers or antennas, and excellent impedance match to insure sharp, ghost-free reception.

The A-102 two-set coupler feeds two v.h.f. or FM receivers from one antenna or mixes two antennas into one line. These two-set couplers feature 12-20 db isolation and 3.5 db loss. The four-set unit (A-104) feeds four v.h.f. or FM receivers from one antenna or mixes four antennas into one line. This unit provides 12-20 db isolation at only 7.5 db loss.

Requiring no power and sealed in weatherproof, non-breakable cases, these couplers can be mounted on an outdoor antenna mast by means of the A-100 hardware kit. The units may also be installed indoors with the terminals concealed.

"CURRENT CHECKER"

Seco Manufacturing Company, 5015 Penn Avenue, South, Minneapolis, Minn. is in production on its Model HC-6 "Current Checker" which is designed to provide TV technicians with a fast, positive, on-the-spot method of checking horizontal output circuits.

The instrument can be placed in the circuit in seconds without disconnecting the cathode and immediately indi-

cates whether the cathode current of the horizontal deflection output tubes is within manufacturers' recommended limits. The proper use of the HC-6 is said to minimize the chance of premature failure of horizontal output transformers and, in some cases, the failure of the power transformer and rectifiers.

The device measures 5¼" wide, 5¾" long, and 1½" high. It comes completely assembled and with operating instructions. Write the manufacturer for further information and price.

TRANSISTOR RADIO LINE

The Electronics Division of *Channel Master Corp.*, Ellenville, N. Y., has entered the receiver field with a new line of transistor radios.

Two 6-transistor models are being offered initially, along with a full line of accessories. The Model 6506 utilizes six matched transistors, plus 1 diode and 1 thermistor. It measures 5¾" long, 3" high, and 1¾" deep and is powered by four 1½-volt penlite cells. Other features include a superhet circuit, push-pull output, built-in ferrite antenna plus a plug-in extension antenna, safety tuning dial, non-breakable plastic case, earphone jack, extension speaker outlet, sealed variable capacitor, and 2½" speaker. The accessories include a cowhide carrying case with leather shoulder strap, magnetic earphone for private listening,

and earphone case. This model is available in black and gold or maroon and bronze.

The Model 6501 measures 4⅝" x 2 13/16" x 1¼" and uses six matched transistors plus 1 diode. A 9-volt battery powers the circuit.

Write the manufacturer direct for full details on the line and prices.

"TRANSFORMERETTES"

Amplifier Corp. of America, 398 Broadway, New York 13, N. Y., has recently introduced a new line of Mumetal-shielded miniature transformers which has been especially designed for transistor applications.

This series of ruggedized transformers is epoxy impregnated for optimum freedom from moisture penetration and housed in drawn, annealed Mumetal shields. All units use nickel-alloy core material and are wound on either Bakelite molded coil forms or nylon bobbins. Bifilar windings and one-piece gapless core construction are used in some units.

Thirteen basic types of input, driver, output, and interstage transformers are available for use in 90 different impedance-matching circuits. Four frequency response ranges are available.

The new "Transformerettes" are primarily designed for miniaturized and transistorized equipment and for industrial, commercial, and experimental applications. Complete technical specifications and factory prices are available from the Transformer Division.

"HYBRID" SET TUBES

The Electron Tube Division of *Radio Corporation of America,* Harrison, N. J., is now offering a 9-pin miniature type tube containing two diodes and a high-perveance power tetrode in a single envelope.

The 12DS7 was specially designed for use in "hybrid" auto radio receivers in which the tube and transistor electrode voltages are obtained directly from a 12-volt storage battery. In such receivers, the diode units are used for AM signal detection and a.v.c. The tetrode unit, which is of the space-charge-grid type, is intended for use as a driver to supply high input power at low distortion to the transistorized a.f. power-output stage.

Space-charge-grid operation of the tetrode unit is accomplished by operating grid No. 1 at a positive potential and using grid No. 2 as the control electrode. This method of operation, in addition to the high perveance of the tetrode unit, enables the 12DS7 to supply high plate current with only 12.6 volts on the plate.

NEW BEAM POWER PENTODES

The Electronic Tube Division of *Westinghouse Electric Corporation,* P. O. Box 284, Elmira, N. Y. has announced the development of two beam power pentodes which have been especially designed to provide reliable vertical deflection to drive wide deflection angle cathode-ray tubes. These 9-pin miniatures will conservatively drive a 110-degree vertical deflection system.

The heater of the 12DT5 is designed to operate in circuits employing 600 ma. series-connected heater strings. Warmup characteristics are controlled to minimize heater surge. The 6DT5 displays the same characteristics as its 12 volt counterpart. Both types feature controlled high zero-bias plate current and low zero-bias screen current at a specified low plate voltage. This low knee characteristic, coupled with a tightly controlled cut-off characteristic, assures the circuit designer of ample linear vertical deflection.

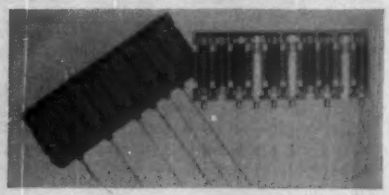
Full specifications on these two new types will be supplied by the manufacturer upon request.

ERIE "PAC" UNITS

Erie Resistor Corporation, Erie 6, Pa. has announced the development of "PAC" (Pre-Assembled Components)

with wire leads for universal wiring.

Formerly available only to manufacturers using printed wiring boards, the new units enable companies using point-to-point wiring methods to em-



ploy "PAC" without circuit redesign.

The capacitor-resistor networks provide capacitance values of 10 μμfd. to .01 μfd. in the ceramic dielectric and from .01 μfd. to .1 μfd. in the Mylar dielectric with tolerance ranges of +100%, −0%, ±20%, ±10% and ±5%. Resistance range of 10 ohms to 50 megohms at tolerances of ±5%, ±10%, and ±20% are available.

Detailed information on this new circuit component will be supplied by the manufacturer on request.

SHORT-WAVE RADIO KIT

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. has added a four-

band, three-tube regenerative receiver to its line of electronic kits.

Suitable for the Novice Amateur as well as SWL's who enjoy "monitoring" the ham frequencies, this receiver covers the standard broadcast band and the 1.7-5 mc., 5-14 mc., and 14-30 mc. short-wave bands. When assembled in its wooden case, the circuit is powerful enough to drive the 4" PM speaker, which is mounted behind a grille on the front panel, to high-level output. Phones may be used by plugging into the rear-mounted jack which automatically cuts out the speaker.

The "Explor-air" will operate on 110-115 volts a.c. or d.c. and measures 10" x 7" x 5". It comes complete with all parts, detailed step-by-step instruction booklet, and giant pictorial diagram. The kit is catalogued as the KT-135.

REPLACEMENT FLYBACK

Chicago-Standard Transformer Corp., 3501 W. Addison St., Chicago, Ill. has announced the availability of an exact replacement flyback for *General Electric* and *Hotpoint* Part No. RTO-196.

The new unit, designated as HO-288, requires no chassis or circuit alterations since it is an exact duplicate, electrically and physically, of the original part.

This *Stancor* flyback is described in detail in Bulletin 548 which is available from the company's distributors or from the manufacturer direct. —30—

NEW RAYTHEON DIVISION

IN A program said to be unique in the electronics industry, Raytheon Manufacturing Company has established a Distributor Products Division which will assume full responsibility and all the needed manufacturing and merchandising resources to team up with the independent parts distributor to their mutual advantage. The new division will stock, in the same warehouses, the firm's complete line of receiving tubes, picture tubes, semiconductors, magnetrons and power tubes, industrial tubes, as well as knobs and other components formerly handled by separate divisions. The consolidation of sources of supply is designed to save distributors both time and money.

Headed by John T. Thompson as manager, the division's key personnel includes F. E. Anderson, general sales manager; John A. Hickey, industrial products manager; Frederick H. Keswick, dealer products manager; William Grey, merchandising manager; E. I. Montague, director of personnel development and trade relations; John Manchester, controller; and Harold Hennig, market research manager. —30—

Sylvania Electric Products Inc. has placed a new 48,000-square-foot engineering, research, and development laboratory in operation at Towanda, Pa. Equipped for advanced experimentation in the fields of high temperature metals, semiconductor materials, and phosphors for lighting and television, the new facility is part of the company's Chemical and Metallurgical Division. The modern building houses engineering offices, laboratory, and pilot plant facilities for more than 100 scientists, engineers, and technicians. The lab was formally opened in October.

To Troubleshoot Pull Tubes

(*Continued from page* 59)

tube, then replacing the fuse, and finally applying power. If the fuse blows now, we can narrow things down considerably. In the circuit for Fig. 4, for example, capacitor C_{36} would probably be shorted. If the fuse doesn't blow, this indicates several other possibilities—a defective horizontal-output tube, defective damper, defective horizontal-oscillator stage resulting in no drive to the output tube, or other trouble causing excessive current through the damper or output tube. These possibilities would then have to be investigated more closely.

In transformer-type sets with fuses in the transformer primary circuit (Fig. 5), similar fuse troubles can be localized by removing the rectifier tube, then inserting another replacement fuse and checking operation. If the fuse blows now, the trouble is in the transformer or primary circuit. If the fuse doesn't blow, the trouble is probably a defective rectifier tube, a short in the "B+" supply, or other more conventional one.

This technique of narrowing down the possible circuit defects by tube removal can also be used in series-filament sets with fuse trouble. For example, assume the "B+" fuse is blown (F_1 in Fig. 6). The fault may be due either to a defect in the "B+" line proper or to a defective stage drawing excessive current which overloads the "B+" line. A simple way to rule out one of these two broad possibilities is to remove a tube in the series-filament line in order to open the filament string, replace the "B+" fuse, and turn the power on. If the defect is in the "B+" line, the fuse will probably blow again. On the other hand, if the fault is a defective tube or a trouble which causes excessive current through one of the other stages, the fuse will not blow since no tube is operating. Further checks are then made on the basis of this test.

Case No. 4. Tube removal can also help localize certain signal-circuit faults. For example, a 60-cycle buzz in the sound may be sync buzz, over-amplified power-supply hum, or pickup from the vertical-sweep circuit. Removing the vertical-oscillator tube in a transformer-type set would quickly determine whether the pickup comes from the vertical circuit or elsewhere in the set.

In series-filament sets, where removal of a tube disables all of the signal circuits, the same effect can be achieved instead by shorting the grid of the vertical oscillator (or other tube being checked) to disable operation of the stage.

Obviously, tube removal is not a revolutionary cure for all defects. Nevertheless it can be a valuable addition to the technician's store of troubleshooting weapons. Of these he can never have too many. —30—

Within the Industry

(*Continued from page 30*)

service manager . . . **JOHN T. HICKEY** is now assistant to the president of *Motorola Inc.* . . . **JAY C. CARVER** has been named to the post of audio sales and merchandising manager for *Record & Sound Retailing* and *The Harrison Catalogs* . . . **EDWARD J. CARNEY** is now manager, advertising and sales promotion, semiconductors and components, *RCA* electron tube division.

• • •

ELECTRONIC INDUSTRIES ASSOCIATION'S board of directors has reaffirmed its position in favor of establishment by the Government of a commission to make a long-range study of the radio spectrum and its usage.

In addition, three new directors were elected: John G. Brooks, president, *The Siegler Corp.;* Jennings B. Dow, vice-president, *Hazeltine Electronics Div., Hazeltine Corp.;* and B. K. Wickstrum, senior vice-president, marketing, *Sylvania Electric Products Inc.*

• • •

REEVES SOUNDCRAFT CORP. has moved to its new home on Great Pasture Road in Danbury, Conn. The plant covers 50,000 square feet and is fully air-conditioned and dust-free . . . **PACIFIC SEMICONDUCTORS, INC.** has added a fifth building to its facilities in Culver City, Calif. -30-

ARMY MARS TECHNICAL BROADCASTS

HERE is the December schedule for the First Army MARS SSB Technical Net whose purpose is the dissemination of technical knowledge by radio.

Transmissions are on Wednesday evenings, 9 p.m. (N.Y. time) on 4030 kc. upper sideband.

Dec. 3—"International Radio Communication Systems" by E. D. Becken, asst. vice-pres. and chief operations engineer, RCA Communications Company.

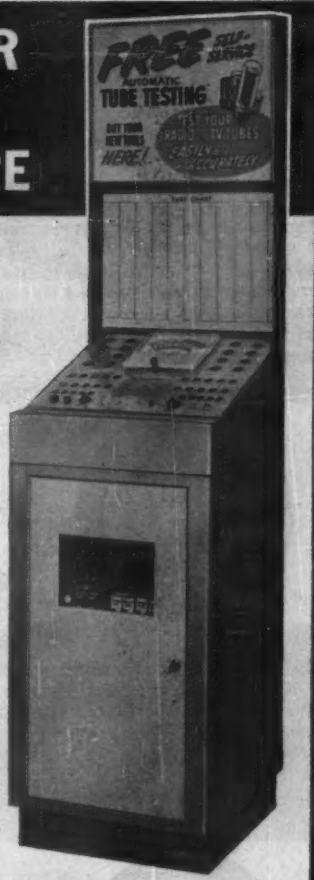
Dec. 10—"FM Multiplex Stereo System" by Murray G. Crosby, president, Crosby Laboratories.

Dec. 17—"VHF Radio Propagation" by Edward P. Tilton, VHF editor, ARRL.

-30-

C. M. Edwards, director of advertising and sales promotion for the Heath Co., Benton Harbor, Mich. is shown below (left) accepting an award from the Direct Mail Advertising Association, Inc. The presentation was made by Colin Campbell, executive vice-president of Campbell-Ewald Company. The certificate was presented to the Heath Co. in recognition of its mail advertising during the year ending August 1, 1958.

THIS SELF-SERVICE TUBE TESTER IS YOUR STEPPING-STONE TO A BRIGHT NEW PROSPEROUS FUTURE



EARN BIG MONEY AND ACHIEVE FINANCIAL STABILITY

If you've ever longed for a business of your own . . . to be your own boss and to work your own hours, then here's your opportunity to get in on one of today's biggest money-making opportunities — *the self-service tube testing business.* It's the easiest business to get into . . . requires no experience, little time and small investment.

A basic principle for making money is to have something work for you, rather than you yourself doing the work. As an operator of a FAST-CHECK SELF-SERVICE TUBE TESTER ROUTE you can be the proud owner of a solid fast-growing business . . . earning money while you take life easy. Business can be started without giving up your present source of income and can be operated from home. All you do is make calls once a week to restock testers and collect profits.

WHAT IS THE SELF-SERVICE TUBE TESTING BUSINESS?

The self-service tube testing business is a take-off on the highly profitable vending machine business . . . Drug stores, luncheonettes, supermarkets, etc. welcome having a tube tester placed in their store. You place testers and tube stock in stores on consignment — the store location contributes floor space for the self-service tube tester — store patrons are offered the use of the tube tester free — they in turn buy their replacement tubes from the tube stock in the tester. The store pays you for all the tubes sold less his commission. Each tester placed can net up to $1000 a year for you.

NO SELLING REQUIRED

Century's self-service tube testers check and sell TV and radio tubes automatically 12 hours a day — 7 days a week. Consumers do their own testing and defective tubes are replaced on the spot for highly profitable sales. *Your testers are your high powered salesmen.*

MANUFACTURER-TO-YOU PRICES

Since we are the manufacturers and sell direct to you, we have been able to price the FAST-CHECKS so low that they represent the greatest value in testers available. Our unusually low prices enable you to place more units with less investment.

FAST-CHECK SPECIFICATIONS

- 46 long lasting phosphor-bronze sockets accommodate all present and future tube types — cannot become obsolete.
- Attractive red and hammer-tone gray durable metal cabinet. Takes only 19" x 19" of floor space.
- Tube compartment with own lock holds 400 or more tubes.
- Removable tube storage trays with specially designed dividers separate tube cartons — make it easy to restock tubes that are sold.
- Large seven inch easy to read meter is extremely sensitive yet rugged — is fully protected against accidental burn-out.
- Completely self-service — easy to operate.
- Built-in 7-pin and 9-pin straighteners on panel for customers convenience.
- Quick reference tube chart lists over 650 tube types — conveniently mounted.
- A colorful illuminated point-of-sale display tops the cabinet — designed to attract everyone that comes into the store.
- Each unit is covered by a 3 month guarantee.

FREE BOOK TELLS ALL ABOUT THIS BOOMING BUSINESS

If you are interested in starting a lifetime business, then ACT NOW and send for FREE book to convince yourself that this is today's greatest business opportunity.

Model SS-1F (floor model) FAST-CHECK SELF-SERVICE TUBE TESTER $134.50 Net

Model SS-1C (counter model)
An ideal unit for shops with limited floor space. $98.50 Net

ATTENTION SERVICE SHOP OWNERS

Put the FAST-CHECK SELF-SERVICE TUBE TESTER in your shop with only a $34.50 down payment. You'll gain a valuable profit producing assistant working for you every open hour.

Do-it-yourself customers will welcome the opportunity to bring their tubes to your store where they can test tubes to their heart's content. If the tubes register "Bad" or "Weak" you are assured of profitable tube sales. And best of all you don't have to stop working when a customer brings in a bag of tubes to check. The FAST-CHECK does it all for you. If on the other hand a customer's tubes register "Good" you are on the spot for consultation or a service call.

Colorful window streamers and advertising material provided FREE by us will attract many new customers to your shop. Servicemen are not only increasing tubes sales, but are actually enlarging their service business as well, with a FAST-CHECK in their shop. Act now! Place a unit in your shop and double your tubes sales . . . save valuable working time.

TIME PAYMENT PLAN

Pay in small monthly payments at net cash prices.

NO INTEREST OR FINANCING CHARGES

CENTURY ELECTRONICS CO., Inc.

111 ROOSEVELT AVENUE
Dept. T-12, Mineola, N. Y.

Please send the units I have indicated below on your TIME PAYMENT TERMS. Include a complete plan of operation — plus all advertising material needed to get started in the self-service tube testing business. I understand no interest or financing charges will be added, and they are shipped on a 10 day money-back guarantee.

Quantity	Description	Unit Price	Extend Total
	Model SS-1F (floor model) FAST-CHECK TUBE TESTER Enclose $34.50 down payment with order for each tester. Balance payable in 5 monthly payments of $20.00 for each tester starting 30 days after shipment.	$134.50	
	Model SS-1C (counter model) FAST-CHECK TUBE TESTER Enclose $23.50 down payment with order for each tester. Balance payable in 5 monthly payments of $15.00 for each tester starting 30 days after shipment.	$ 98.50	

All prices net F.O.B. Mineola, N. Y.

Total Amount
Advance Payment
Balance

☐ I am interested. Please send me FREE book and particulars about setting-up a tube tester route. No salesman will call.

☐ ***CHECK HERE TO SAVE SHIPPING CHARGES***
Enclose total amount with order and Century will pay all shipping costs. 10 day money-back guarantee.

Name.....
Please Print

Address.....

City..... State.....

By BERT WHYTE

AS EXPECTED, the New York High Fidelity Show of the Institute of High Fidelity Manufacturers was widely heralded as the "dawn of the Age of Stereo." Anyone who attended the show can tell you that this appellation was thoroughly justified. Man, you just couldn't escape stereo in all of its forms.

From every room emanated two-channel sound backed up by aggressive two-fisted selling. Yessir, the "putsch" was on for stereo and, friends, you should have seen the enthusiasm! This is the truly amazing thing about this whole phenomenon . . . the acceptance has been so immediate and so complete that one might think that the public has been waiting for stereo for years. Of course, in any show where the emphasis is on component hi-fi, one expects strong support from the "hi-fi cadre." What is more astonishing is that there were great numbers of people attending the New York show, who quite obviously were not audiophiles, but who displayed a lively interest in stereo. Like it or not, one must admit that this was in no small measure the result of the heavy advertising the "package manufacturers" are giving to stereo. Without going into the logistics of the situation, it is obvious that whatever side of the fence . . . component or package . . . stereo has arrived, is here to stay, and is bound to have a profound effect on our musical lives!

As to the wares displayed at the show, they were almost without exception designed for stereo usage. There was a rash of new stereo preamps, self-contained stereo amplifiers, many small new speakers in matched pairs, as well as stereo pickup cartridges of both magnetic and ceramic varieties.

The cartridge exhibits were very well attended and rightly so . . . for this is the major area of newness . . . and controversy . . . as far as stereo disc is concerned. After all, most hi-fi enthusiasts can convert to stereo fairly easily by adding to their present monaural rigs a duplicate or equivalent of the equipment they now own. This is familiar ground and the audiophile knows what to expect. But a stereo pickup is really an unknown quantity to most. There are more than a few on the market and clearing one's way through the literature that surrounds them is not easy.

If pickups were a sore point in monaural usage, their stereo counterpart is even worse. Among the things that have harassed the stereo disc enthusiast, is difficulty in eliminating hum, poor tracking ability, excessive stylus pressure, and poor interchannel separation. With so many stereo discs variable as to the manner in which they were cut, this trouble of channel separation is often compounded. Of course, the picture isn't entirely dark . . . there are some pickups that perform quite admirably, but deciding which to buy will call for controlled concentrated listening and comparison.

The major stereo emphasis at the show was the disc, with tape still present but, at the moment, in the background. There was, however, one other stereo item which made its debut at the show and this was the long anticipated adapters for FM multiplex stereo. This was particularly gratifying to me, as long-time readers of this column will remember that quite a few years ago I campaigned for this type of stereo transmission rather than the AM-FM variety and, in fact, I am happy to say that I had an active part in the promotion of the multiplex stereo idea.

Here is the situation as it stands now . . . virtually all of the component tuner manufacturers such as *Fisher, McIntosh, Pilot, Madison-Fielding, Harmon-Kardon, Sherwood,* have become licensees for the *Crosby* "Compatible FM Multiplex" system. All of them intend to produce multiplex adapters under this license and several of these companies had production models displayed and actually demonstrated stereo multiplex at the show. This was accomplished by tuning to New York station WBAI, which is the first in the country to have installed the *Crosby* transmission equipment.

Although operating on an FCC experimental permit at present, it is hoped that this will soon become a permanent situation. As with almost any new thing there have been a few teething troubles, but for the most part the response of the fortunate few equipped with multiplex adapters is quite enthusiastic. I have one of the adapters at home and can report to you that the other evening WBAI did a multiplex stereo transmission of the *Victor* tape of "South Pacific." My home is 40 miles from the transmitter and yet in terms of all the stereo effects, plus frequency wideness and dynamic range, the tape sounded almost the same as when I reproduce it on my *Ampex*. When I switched to hearing the tape from the monaural tuner alone, the *Crosby* system lived up to its claims and there was a perfectly balanced monaural signal of the left and right components of the stereo tape.

When will multiplex stereo become a general country-wide service? This depends on several factors. Negotiations are in progress with FM stations in almost all sections of the country and in New York, for example, the giant of the *National Broadcasting Co.*, WNBC, reportedly will begin stereo multiplex transmission before the end of this year. The fly in the ointment, however, is that at present the FCC will issue only experimental permits, pending a decision which will es-

The opinions expressed in this column are those of the reviewer and do not necessarily reflect the views or opinions of the editors or the publishers of this magazine.

tablish multiplex standards. As you may know, one of the other uses for multiplex is the transmission of two *separate* signals, or programs, from a single FM station. This has found use in the broadcasting of background music to stores, restaurants, etc.

The proponents of another method of multiplexing have proposed that a *third* channel emanate from the same FM station. In this way, two of the channels could be used for stereo, while the third channel would provide the background music. This would afford additional revenue, which it is argued would help pay for the stereo. There is certainly merit in this idea, but unfortunately there is a serious flaw in actuality. Because of the limitations of available bandwidth, when *three* channels are muutiplexed on a single FM transmitter each channel is restricted to roughly 5000 or 6000 cycles and, in addition, the signal-to-noise is much poorer. Even worse, this system is incompatible with monaural FM tuners. When tuning to this type of signal, only *one* channel . . . either the left or right as the case may be . . . can be received and the listener is obviously off-axis. In other words, when listening to a multiplex stereo FM transmission that does not employ the wide-range *Crosby* system, you must contend with low fidelity and the poor monaural listener must contend with a "lop-sided" program. With some stereo material which has wide separation and in the case of concertos and vocalists who may be on the opposite channel to that being received, the result can be devastating.

It is generally felt that the FCC will not give approval to any multiplex stereo system in which the monaural FM listener (who after all will still be in the majority for a long time) receives a degraded signal. It is this impression and the knowledge that the *Crosby* system is capable of coping with all these objections that has given multiplexing its present impetus. Thus stereo has come into full flower, we have stereo tape, disc, and FM and I think it is fairly safe to say that after all the smoke has cleared away, that no single form of stereo will dominate the hi-fi scene, but each will have its supporters and a happy state of co-existence will develop.

In the meanwhile, there's much to be done with the stereo disc and while this column will most certainly report on the best of them, the coverage of monaural discs will also continue. I may get shot for saying this, but forgetting for a moment the virtues of the stereo effect, and apart from this . . . the technical quality of the finest monaural discs in terms of wide frequency and dynamic range, low distortion and quiet surpasses that of all but a few of the stereo discs thus far issued!

BERLIOZ
REQUIEM

Hartford Symphony Orchestra and Chorale conducted by Fritz Mahler. Vanguard Stereo VSD-2006. Price $11.90.

Orchestra and Chorus conducted by Hermann Scherchen. Westminster Stereo WST-201. Price $11.90.

The advent of a recording of the Berlioz "Requiem" in its monaural format was an occasion for some excitement. The advent of two such recordings at the same time could be considered quite extraordinary. And, at this stage of the stereo disc, the advent of *two* stereo disc recordings of the Berlioz "Requiem" is nothing short of staggering! This vast work has, of course, been waiting, as it were, for stereo to come along so that its tremendous musical canvas could be accommodated. Imagine, if you will, a huge augmented orchestra, several hundred choris-

ters, four brass bands, and sixteen (count 'em) tympani, and you'll get some idea of the scope of this work.

There have been two recordings of this in the LP era: the first was recorded in St. Eustace Church in Paris and, while an exciting performance, suffered from excessive reverberation; of more recent vintage, a recording made by the Rochester Choral Society which, while more modern in sound, still left much to be desired and was not particularly distinguished in performance.

It would be nice to report that either or both of these present stereo disc recordings of the "Requiem" was a great success and the sonic thrill supreme. Unhappily, both fall far short of expectations. In the *Vanguard* recording, Fritz Mahler gives us a reading which is workmanlike and competent but not overly inspired and there is a large chorus whose enthusiasm is pleasing but whose talents are somewhat wanting. But the main fault here is the fault of so many of these early stereo disc recordings. I should, in all fairness to *Vanguard*, point out that the dynamic range of the Berlioz "Requiem" is one of the widest in the literature, making the task of cutting a satisfactory stereo disc truly formidable. The trouble here, of course, is level. The very opening of the work is many, many decibels below what the same opening would be on a monaural disc and when it comes to the huge crashing climaxes of this work, especially the all-out fervor of the "Tuba Marum," one has to crank up the gain on the amplifier to such an extent that unless the amplifier is of very high quality and extraordinarily quiet, the music will be ruined by excessive hum and rumble. If your amplifier can do this, admittedly the effect of the climax is stupendous. From a strictly stereo standpoint, this *Vanguard* recording is pretty good, meaning that directionality is easily apparent, the hole-in-the-middle has been well filled, and there is a strong feeling of depth.

In the *Westminster*-Scherchen recording, they went all out for authenticity in the performance. This was actually recorded in the Invalides in Paris where Berlioz conducted the first performance. This was a praiseworthy and notable endeavor and one which, I am sure, called for considerable courage, since one listen to the reverberation characteristics of the Invalides would be enough to drive the average recording engineer stark mad. No doubt the engineers tried mightily but to no particular avail. The reverberation time is so great that for the most part the sound is amorphous and is a particularly devastating thing with stereo. Except in the very loudest sections, directionality was something one had to look for or listen for and what should have been the shattering roar of sixteen tympani was more reminiscent of 60-cycle hum. In other words, articulation was almost totally absent. There is no denying that there were, however, some fascinating sounds in depth and, in the right places at the right time, some fabulous antiphonal effects.

Performance-wise, Herr Scherchen has chosen to impose some of his ideas in certain places in the score and, at other places, to act quite well-behaved and stick to the letter and note. He had the advantage of a very capable, well-trained choir and an orchestra used to Berlioz. The result of all this is a somewhat jerky and uneven performance which has its compensations in some vast and glorious outpourings of sound. The *Westminster* recording suffered, but not quite as greatly, from reduced level. In both recordings, the bass is diminished from its monaural counterpart and once again this seems to be a concomitant of less-than-satisfactory stereo disc recording.

In summation, neither performance can be

said to be the final word on the subject and, in matters of sound, the perfect stereo realization of this work is yet to come. Let's put it this way. If you are an absolutely wild-eyed admirer of the Berlioz "Requiem," either of these two recordings may give you some of that thrill you are looking for but if your interest in the "Requiem" lies in the musical as well as sonic aspects of the work, then one can only ask for patience. Too bad, but a tip of the hat to both *Vanguard* and *Westminster*, both considered "small" companies, but whose ideas are big and most of the time, anyway, very fruitful.

BEETHOVEN
PIANO CONCERTO NO. 5
(THE EMPEROR)
Clifford Curzon, pianist, with Vienna Philharmonic Orchestra conducted by Hans Knappertsbusch. London Stereo CS-6019. Price $4.98.

This is one of the first Piano Concertos to be heard on a stereo disc and would that all the rest are as good as this! In its monaural format, this was a tremendous experience. Now hearing it in stereo, it is even more apparent what a superb performance this is. This has always been a Curzon specialty and he affords us a performance in the grand old manner—full, robust, a thundering peroration that is tremendously exciting. Hans Knappertsbusch, who is not normally noted for his displays of ebullience, seems to have been caught up in the mood and spirit with which Curzon endows the work and he is in excellent rapport at nearly all times and elicits from the Vienna Philharmonic some of the most exemplary string playing I have heard in a long time.

This has the stereo virtues in prolific abundance. Instrumental separation and directionality are very apparent. There is an almost magical balance between piano and orchestra. The whole piece has a sonic strength and forward projection that is almost overwhelming. The recording was made moderately close up but not so much so that the reverberation can't lend itself to the situation and furnish us with a compellingly realistic sense of depth. Add the virtues of wide dynamics fully realized, good high level sound throughout, and nice quiet surfaces and this gives us a final nugget of desirability. Don't miss it!

RAVEL
BOLERO
MOTHER GOOSE SUITE
CHABRIER
BOURÉE FANTASQUE
Detroit Symphony Orchestra conducted by Paul Paray. Mercury Stereo SR90005. Price $4.98.

With the great variance in the quality of stereo discs I was most anxious to hear some samples of *Mercury's* efforts in this new field. Most particularly, I wanted to find out if *Mercury* had been able to impress on a stereo disc, the same high level of technical excellence that has characterized their brilliant "Olympian" series monaural recordings. On listening and comparison, it was most pleasant to find that while the stereo disc could not match its monaural counterpart in some respects, on the whole it was of very high quality and deserves to share with *London Records* and a few others, the distinction of producing the best of today's stereo.

I was quite impressed with the fact that the *Mercury* engineers had been able to retain almost as great a dynamic range and over-all volume level as their monaural product. Nor was this accomplished by drastically reducing bass response. The low strings and the bass drum and tympani were very clean and solid and at no time did I experience difficulty in tracking the disc. It must be noted, however, that high-frequency

response is down somewhat in comparison to the monaural recording. This is, I understand, not uncommon with almost all stereo discs, being an inadequacy of the stereo cutter.

The stereo effects *per se* were well maintained . . . there was excellent directivity and instrumental positioning, good center fill which afforded a nice over-all "wall" of sound, and the acoustic treatment was such as to give a very full sense of airy spaciousness and depth. All the various choirs of the orchestra were as bright and forward as is usual with *Mercury*. On the debit side could be listed such things as an occasional high level overload, probably due to the failure of the cutter to maintain sufficient interchannel separation at such high peak inputs, and some of the "swish-swash" types of odd modulations which seem to affect stereo discs at times. Of course, much of this is due to spindle hole eccentricities and warpage and can be avoided, at least partially, by scrupulous inspection of the records you purchase.

As to the music, as has been noted in the earlier monaural review, Paray is masterful in his readings of Ravel and as heard with all of the added virtues of stereo, his art is all the more appreciated. The "Bolero" is an excellent recording to use for checking whether or not your speakers are properly balanced and in phase. If all is correct, that wonderfully insistent drum that grows ever and ever louder will be positioned exactly between the two speakers.

All in all, a very auspicious beginning for *Mercury* stereo disc and now we can look forward to many of the fine recordings they have tucked away in their stereo backlog.

TCHAIKOVSKY
PIANO CONCERTO #1
Van Cliburn, pianist, with a symphony orchestra conducted by Kiril Kondrashin. Victor LSC 2252. Price $4.98.

After all the whoop-la about Van Cliburn, frankly I was a bit cynical and expected that when I finally got a chance to hear him, I would find that he had many graces and virtues all of which had been blown up quite out of proportion in comparison with the talents of some of our great established artists. Imagine my surprise when he turned out to be "as advertised"! He has truly astonishing ability for one so young and displays a tremendous *bravura* style in the "grand tradition". Yet for all his thundering and drama, he is a true poet and his eloquent, beautifully proportioned reading is as ingratiating a performance as I have heard in years.

This is the stereo version and, as such, helps a great deal in maintaining a sense of realism. It is not, however, a completely satisfactory stereo recording. The level was several db below monaural standards, there was a definite diminution of bass reponse, an annoying lack of body in the strings. If your system is quiet enough to bring up the level and the bass response, things sort out a bit and as directivity and depth were fairly good the over-all effect reasonably stimulating.

MAHLER
SYMPHONY #2 (RESURRECTION)
New York Philharmonic conducted by Bruno Walter with Emelia Cundari, soprano; Maureen Forrester, contralto; Westminster Choir. Columbia M2S601. Price $7.96. Two discs.

If you don't know this work, the first thing I can do here is to urge you to listen to one of the most beautiful and great of symphonic masterpieces. This is a huge work and the problems in recording it are formidable. Needless to say stereo is a big help in this, but as with so many stereo discs, it

presents problems of its own. There are some passages of transcendent beauty which could only have been realized with stereo . . . there are other moments which are somewhat less than satisfactory. Stereo effects are fair here, but on a minimal basis. Directivity was all right, but the over-all balance and especially the handling of the acoustic perspective was far from perfect. Level was down a bit, bass reduced somewhat, dynamic range (so important in the stirring finale) was restricted. And the sin of having the solo voices override the chorus in the finale is almost unpardonable.

Despite all this, this is a stereo recording I wouldn't want to part with unless there was a very, very good replacement. This affection is based on the appeal of the work, the fine playing of the Philharmonic and, above all, the inspired reading of Bruno Walter. For him this was truly a labor of love, a fact which is audibly evident in every bar and measure of the score.

RIMSKY-KORSAKOV
THE TALE OF THE TSAR SULTAN
MAY NIGHT
RUSSIAN EASTER OVERTURE
L'Orchestre de la Suisse Romande conducted by Ernest Ansermet. London CS6012. Stereo. Price $4.98.

This is still another fine stereo disc from *London,* which has now settled down to turning out stereo discs which for the most part one can buy with confidence that the stereo aspects will be of high technical excellence. A very tasty potpourri of Rimsky who surely must have composed many of his works with stereo in mind. Or so it almost seems, so perfectly does his orchestration lend itself to this medium. Directionality, depth perspective, fine bright projection, superb aural positioning of individual instruments, all add up to splendid sounding disc.

If these numbers are among your favorites monaurally, you'll really get a lift from these stereophonic versions!

HITS I MISSED
Ted Heath and his orchestra. London PS116. Price $4.98.

For stereo in the popular vein this is hard to beat. Ted Heath plays a group of numbers such as "Ebb Tide," "High Noon," "Three Coins in the Fountain," "Love is a Many Splendored Thing," and others with very clever arrangements which take full advantage of stereo's capabilities. This is very full, big band stuff, with typical Heath drive and spirit.

This is a stereo disc with level to burn and it sounds great even on the very small packaged stereo rigs. —30—

"JOIN A RADIO CLUB"

THE Chicago Area Amateur Radio Club Council is sponsoring a "Join a Radio Club" campaign to assist those interested in amateur radio find the organization meeting their particular hobby objectives.

To assist in making this choice, the Council has published a free directory of ham clubs which is being distributed by amateur radio supply stores in the Chicagoland area or may be obtained by sending a self-addressed, stamped envelope to Ray Birren, W9MSG, 702 Spring Road, Elmhurst, Ill., or George Boyd, W9SPT, 3540 N. Seeley Ave., Chicago.

The directory lists meeting places, dates, officers, and activities. Clubs range in specialization from u.h.f. to mobile to social. In addition, there are two ham clubs for the distaff ops. The latchstring is out and the Council welcomes inquiries from Chicago area hams. —30—

Semiconductor Capacitors

(*Continued from page 47*)

could be used in ham transmitters, signal generators, and the like. In this circuit R_1 is a load for the audio signal and C_2 is an r.f. bypass capacitor. R_2 is the r.f. isolation resistor (or r.f. choke), C_1 the d.c. blocking capacitor, L_1-C_3 the oscillator tank circuit, and C_1 the "Varicap," which is effectively across the tank circuit. The center frequency of the oscillator may be controlled by varying the d.c. bias through R_3. Signal voltage across R_1 varies the bias on the "Varicap," changing its capacitance and the resonant frequency of the tank circuit, resulting in frequency modulation of the oscillator.

A very unusual application of the variable capacitor diode has been under study for some time. This is its use as the variable reactance component in a whole new class of amplifiers known as variable reactance or "varactor" amplifiers. These units require a variable reactance, or "varactor," as the active element. The semiconductor diode capacitor can serve as the "varactor" since its capacity and thus its reactance varies with the applied voltage.

Extensive work on "varactor" amplifiers has been carried out at *Bell Telephone Laboratories*, where it has been found that useful low-noise amplication is possible with the semiconductor diode serving as the "varactor" element. In fact, using several of the diodes in a sort of traveling-wave-tube configuration, a bandwidth of 100 megacycles at a frequency of 400 megacycles has been achieved. This amplifier introduces less noise into the signal being amplified than conventional vacuum-tube amplifiers or mixers, thus making it potentially useful in u.h.f. television receivers.

In another experimental diode amplifier undergoing tests at *Bell Telephone Laboratories*, useful low-noise amplification was obtained at 6000 megacycles, with a bandwidth of about 8 megacycles. Such performance indicates that this type of amplifier can be of value in improving the sensitivity of microwave receivers associated with such systems as radar, radio astronomy, and microwave relays.

Another interesting application of the semiconductor diode capacitor is its use as an up-converter with gain. In a new type of microwave system under development at *Bell Telephone Laboratories*, such diodes are used to provide gain in up-converters where the frequency is changed from approximately 70 megacycles to about 6000 megacycles. This is the first instance of up-conversion using a semiconductor diode in which there was no measurable loss.

From the foregoing we can see that solid-state research has led to a new device which shows promise of becoming an extremely useful component in the electronic industry. —30—

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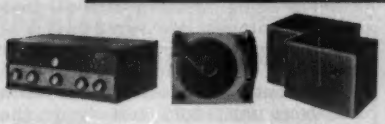

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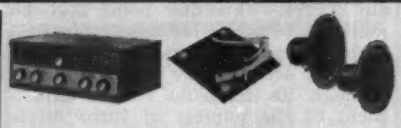

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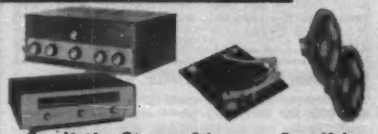

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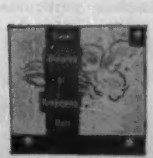

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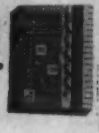

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Versatile LC Meter

(*Continued from page* 41)

Inductance measurements are made in the same direct manner, the remaining 180 degrees of the dial face being utilized for coil values. This arrangement results in a positive, easily read dial.

The circuit is stable and readily adjusted. Parts placement is not critical, the only precaution being that coil L_2 must be constructed and wired exactly as pictured. (See Figs. 2, 3, and 4.) Connections of correct polarity are a "must."

Construction

For ease of assembly, the small parts are pre-mounted on an insulating strip (Fig. 3) in lieu of a chassis. After wiring, the strip is bolted to the cabinet, using small brackets. The meter tuning capacitor C_3, and the "Sensitivity" potentiometer, R_3, are best mounted before attaching the strip.

Calibration

With the switch set to "C" (capacity) and clip leads *not* touching, position the main dial so that the plates of C_3 are fully meshed. Now, turn the L_2 coil slug until a pronounced meter dip occurs. This dial point may be marked as "zero," for the capacitance scale. If a minimum meter reading does not occur as the slug is adjusted through its complete range, adjustment of the number of turns on L_2 may be necessary to obtain resonance. Silver micas of 5 per-cent tolerance are preferred for use as calibration standards to set up the rest of the scale; however other types, of known values, may be used.

Inductance scale calibration is equally simple. Switch to "L" (inductance) being sure that the leads *are* clipped together this time. Rotate the dial again to the same, fully meshed point. Adjust the L_3 slug for a minimum meter reading. This point becomes the inductance scale "zero." Standards for calibrating the inductance portion of the dial may be video peaking coils, r.f. chokes, and other known values of inductance. A value of 200 microhenrys should be used for calibrating the high-value end of the dial, adjusting the L_4 slug for a meter dip. As in the case of the capacitance range, known-value coils are clipped to the instrument, the dial is rotated for a meter minimum and the dial marked accordingly. This process is continued with different coils, for as many calibration points as desired.

Operation

The simplicity of use has already been outlined. For in-the-circuit use, capacitors may be accurately measured even though paralleled by resistances as low as 10,000 ohms. Additional uses are many, including measurement of transmission-line capacitance, wiring, and component stray capacitance, etc. Sealed coils, i.f. transformers, and other inaccessible windings are conveniently measured. The meter "Sensitivity" control R_3 is provided to limit the grid current and permit on-scale meter readings under all conditions. Since the tube is well loaded, only sufficient grid current should be used to enable reliable readings.

Clearing a single TV chassis "dog" more than justifies the small investment in this versatile instrument. This utility is being obtained with all these other advantages: Measurements down to 1 $\mu\mu$fd., in the circuit, with a single, permanent test lead for all work; crystal-controlled accuracy in a stable, drift-free unit; cold test leads that eliminate shock despite the absence of an isolation transformer; and instant heating without warm-up.

Also, the instrument provides indication of shorted and open conditions; permits fast, one-hand operation with a single, direct-reading scale that needs no range-switching; and is made up of standard, rugged commercial parts, with the exception of the coils, which are easily hand wound. It is compact and light enough (less than 3½ lbs.) to create no space problem and to be carried about easily. Its current drain is so low that it may be left on continuously. —30—

Fig. 3. Rear view of chassis showing the location of important components.

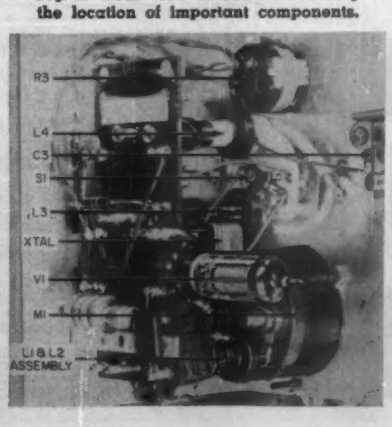
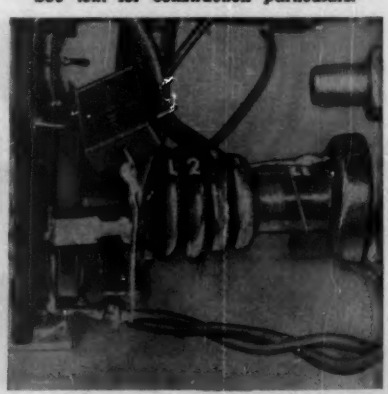


Fig. 4. Close-up of the L_2 assembly. See text for construction particulars.



LORAN R-65/APN-9 RECEIVER & INDICATOR

Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used. Value $12.00.
Our Price **$89.50**

TS-100/AP OSCILLOSCOPE (worth $750) OUR LOW PRICE $33.33

Can be used with linear sweep or general purpose test scope. Cables included. Also used with circular sweep as precision range calibrator. Self-contained in metal case 8" x 12¼" x 16" desp. For 110 V 50 to 1200 cycles AC. Excellent used, like new, with all tubes including crystals and C. R. Tube.

SCR-522 2-METER RIG!

Terrific buy! VHF Transmitter-receiver, 100-156 Mc. 4 channels, Xtal-controlled. Amplitude modulated voice. They're going fast! Excellent condition.
SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION.....Special **$33.33**
Receiver only, with all tubes.....$19.50
Transmitter Only, with all tubes.....$22.25
Accessories for above available.

BC-620 FM TRANSCEIVER, 20-28 Mc. BRAND NEW..... **$9.95**
PE-120 6-12V POWER SUPPLY, with Tubes and Vib, NEW..... **$11.95**
Shock Mt. Rack, NEW..... $2.95
ARB Receiver 4 band 195-9050 Ke, with all Tubes, Like New..... **$17.95**
Brand New, with Tubes and Dynamotor.....$34.50

LORAN APN-4
FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, BRAND NEW..only **$48.49**
Complete Kit of Accessories for Above: PE-206 Inverter, Set of Plugs, Visor for Indicator, Operation Manual, ALL BRAND NEW..... **$49.50**

SPECIAL APN-9A LORAN Receiver Indicator, less tubes, NEW (demilitarized) **$24.50**

I-152-AM ALTIMETER INDICATOR
Brand New, With Tubes.
Only **$17.95**

LORAN APN/4 OSCILLOSCOPE

Easily converted for use on radio-TV service bench.

Completely Assembled

BRAND NEW! Supplied with 5" Scope, type 5CP1 only **$19.95**
Excellent. Used $14.95

DYNAMIC HANDMIKE, with "Press-to-talk" Switch on handle, cord and plug—BRAND NEW, only....$2.95
DYNAMIC HANDMIKE, aircraft, made by Telephonics Corp. Press-to-talk switch on mike. BRAND NEW $4.95

Hi-Fi DYNAMIC HEADSET with Cushions
Freq. Range: 40-14000 CPS. No Distortion. **$7.95**
BRAND NEW .....

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	...Carbon Hand Mike....	$4.95	$7.45
T-30	...Carbon Throat Mike...	.39	.79
T-45	...Army and Navy Lip Mike		1.33
T-24	...Carbon Mike.....		3.95
TS-9	...Handset		3.88
RS-38	...Navy Type.....	2.79	4.95

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	..High Impedance.....	$2.25	$4.75
HS-33	..Low Impedance	2.79	4.75
HS-30	..Low Imp. (featherwt.).	1.25	1.99
H-16/U	.High Imp. (2 units)...	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW, PER PAIR....$3.45
CD-307A Cords, with PL55 plug and JK26 Jack ..... .99
Earphone Cushions for above—pair..... .50

Type	Each	Type	Each	Type	Each
2C42	$4.95	VR150	.49	826	.44
5D21	4.50	807	1.19	829B	7.50
RK65	7.25	813	6.95	832A	9.95
VR105	.49	815	2.99	5CP1	2.45
				3FP7	1.44

FL-8 FILTER.....79¢

WILLARD 6-VOLT MIDGET STORAGE BATTERY
2 Amp. Hour. BRAND NEW. 2¾" x 1-13/16" x 2⅝". Uses Standard Electrolyte.....Only $2.69

2 VOLT BATTERY "PACKAGE"
1—2V. 20 Amp. Hr. Willard Storage Battery $2.75
1—2V. 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells).... 1.49
ALL BRAND NEW!
Combination Price **$5.45**

110V AC to 110V DC RECTIFIER & CHARGER

Manufactured by Hallicrafters
INPUT: 95 to 125V 50-60 cycle AC, or 190 to 250V 50-60 cycle AC.
OUTPUT: 115V DC up to 400 Ma.; 115V AC up to 4.35 Amps. This unit is ideal for Garages, Gas Stations, Auto Supply Stores, to maintain a series of batteries on display. Also fine for Research Labs, Engineers, Manufacturers, operate DC Teletype Equipment, etc. A TERRIFIC BUY AT OUR SMASHING LOW PRICES!! Like New..... **$11.95**
Brand New $14.95

BC-652A RECEIVER

Hot Special! 2 to 6 Mc Receiver, 2-band, complete with all tubes and 13V dynamotor. Fine for 80-meter Ham band. Marine etc. Provides for CW, MVC, AVC. Speaker jack and two headphone jacks. Like New, only..... **$29.50**

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc F.M. Two preselected channels crystal controlled. 5 to 10 watts. Complete with speaker, tubes. Brand New **$11.95**
Exc. Used $7.95

Vibrator Supply for 6-12-24 Volts, NEW....$2.95

BC-645 XMTR RECEIVER

15 Tubes 435 To 500 MC

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc, television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs..... **$29.50**
PE-101C DYNAMOTOR for BC-645, has 12-24V input (easy to convert for 6V Battery operation) .....only **$7.95**
UHF ANTENNA ASSEMBLY, for BC-645..$2.45
Complete set of 10 Plugs for BC-645 ..... **$5.50**
CONTROL BOX for above.....$2.25
SHOCK MOUNT for above.....1.25
CONVERSION BOOKLET. Instructions for most useful surplus rigs..... **$2.50**

NEW VALUES—JUST ARRIVED!

BC-348 SUPERHET RECEIVER. Locally controlled 8-tube 6-band receiver for aircraft, communications type, for voice, tone and CW. 200 to 500 Ke and 1.5 to 18 Mc. For operation on 24 V DC with self-contained dynamotor. Complete with tubes.
Exc. used **$88.88**

AN/ARN-7 AIRCRAFT NAVIGATIONAL INSTRUMENT. Superhet radio receiver. Range 100 Kc to 1750 Kc in 4 bands.
Exc. used..... **$59.50**

AR/ARN-6 RADIO COMPASS EQUIPMENT. Frequency 100 to 1750 Kc in 4 bands. 24 V DC operation.
Exc. used **$119.50**
BRAND NEW $169.50

BC-733 VHF 10-TUBE AIRCRAFT RECEIVER. 6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks!
Exc. used **$9.95**
BRAND NEW $12.95
Dynamotor for above 12/24 V.—Now $5.95

AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision laboratory instrument used to monitor or indicate frequency of any signals within its range. Includes wide and narrow band *IF* strip selected from panel. Outputs provided for attachments to pulse analyzer, panadapter, etc.
Input 115 V 60 *cy.* BRAND NEW **$69.50**
Tuning Units for above—each.....$39.50

AN/ARC-1 Airborne radiophone ground to plane Rcvr-Xmitter. 10-channel xtal controlled, easily converted to 20 or 50 channel, VHF 100 to 156 Mc AM. Complete with tubes, mtg rack, dynamotor. OUR LOW PRICE **$89.50**
Exc. .....

AN/ARN-5A AIRCRAFT RECEIVER. 11 tube superhet, 3-crystal control UHF for static-free reception.
Exc. used with tubes..... **$16.95**
BRAND NEW $19.95

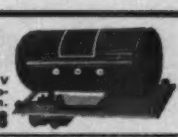
BC-312 RADIO RECEIVER FOR VEHICLES

6 Bands 1500 KC to 18 Mc. continuous tuning. Phone and CW, internal 12v. dynamotor. Swell ham mobile receiver very clean, diagram included, Exc. Used..... **$54.50**

Please include 25% Deposit with order—Balance C.O.D. 50¢ Handling Charge on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C.

G & G Radio Supply Co.
Telephone: CO 7-4605
51 Vesey St., New York 7, N. Y.

MOBILE-MARINE DYNAMOTOR



Input 12V DC. Output: 625 V DC @ 225 Ma, for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE... **$7.88**

OTHER DYNAMOTOR VALUES: Type	Input	Output	Excellent Used	BRAND NEW
DA-19-A	28V 11A	400V .400A	$4.99	$6.95
DM-28	28V	224V .07A	2.95	4.95
DM-32A	28V 1.1A	250V .05A	2.95	5.95
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.95
DM-34D	12V 2A	220V .080A	4.25	5.50
DM-37	25.5V 9.2A	625V .225A	5.95	8.95
DM-40	14V 3.4A	172V .138A	1.75	3.45
DM-53A	28V 1.4A	220V .080A	3.95	5.95
PE-73C	28V 20A	1000V .350A	8.50	11.50
PE-86	28V 1.25A	250V .050A	2.95	5.24
PE-126	28V 11A	400V .400A		6.95
2880	14V 2.4A	250V .060A	....	5.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC.....	$14.95	$16.95
BC-454	Receiver 3-6 Mc.....	9.95	12.95
BC-455	Receiver 6-9 Mc.....	10.95	13.95
BC-450	3-Receiver Control Box.....	1.49	1.95

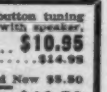
110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions..... **$7.95**
Factory wired, tested, ready to operate.....$11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only..... **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW.. **$7.88**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal.
BRAND NEW **$7.88**
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal.
BRAND NEW **$12.95**
ARC-5/T-19 TRANSMITTER—3 to 4 Mc. BRAND NEW complete with all tubes & crystal **$8.88**

BC-456	Modulator	USED 2.49	NEW 4.95
BC-451	Transmitter Control Box..	1.25	NEW 1.49

UNIVERSAL POWER SUPPLY KIT For All Command Transmitters and others with similar power requirements. Input: 117V 60 cycles AC. Output: 450 V DC @ 150 Ma., 250 V DC @ 50 Ma., 24 V DC @ 2 Amps. Specially designed for Command Xmitter power requirements, but can be used on other similar equipment. Carefully designed, uses quality components. A really substantial, good-looking unit, very low priced! **$29.50**

ARC-5/R28 RECEIVER



2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. **BRAND NEW**.. **$24.45**
110V AC Power Supply Kit for above..$9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes.
BRAND NEW..... **$21.50**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. BRAND NEW, less tubes.....$7.95
Excellent Used, less tubes.....$5.95

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes..... **$16.95**
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal..... **$12.45**
MODULATOR for above, new with tubes.....$4.95

BC-603 FM RECEIVER. 10-channel push button tuning or continuous tuning, 20-28 Mc. Complete with speaker, tubes, squelch.
Exc. **$10.95**
BRAND NEW $14.95
12 or 24V Dynamotor for Above
Exc. Used $4.25.....Brand New $5.50
BC-683 same as above except 27 to 38.9 Mc. **$19.50**
BRAND NEW $24.95
AC POWER SUPPLY for BC603, 683. Interchangeable, replaces dynamotor. No revr change except add on-off switch to front panel. Provides 220VDC @ 80 Ma, 24VAC @ 2 Amps. Complete kit, with easy instructions **$10.50**

BC-906 FREQ. METER—SPECIAL!

Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE **$9.99**

BC-221 FREQUENCY METER

SPECIAL BUY! This excellent frequency standard is equipped with original calibration charts, and has ranges from 125 Kc to 20,000 Kc with crystal check points in all ranges. At our smashing low price it's FIRST COME FIRST SERVED! Hurry, quantity is limited! Like New....Only **$88.88**
BC-221 Modulated Type....$129.50
CABINET for above BC-221..... **$3.99**
Original 1000 Kc Crystal for BC-221.
BRAND NEW.....$8.45

SCHEMATIC DIAGRAMS For any equipment on this page, each.. 65c

Mac's Service Shop

(*Continued from page 66*)

compare the pattern produced by one half of the yoke winding with that produced by the other half to see if any unbalance exists. Admittedly this takes time, but when you don't have a replacement yoke with you it could be a great help in pinpointing trouble and making an accurate estimate."

"How about this probe that looks like the baby brother of a grease gun?"

"That's called a 'Slave Oscillator.' Actually it contains separate vertical and horizontal multivibrator oscillators that can be substituted for those in the TV set. The 12BH7A tube filament is supplied through a line cord resistor. 'B' voltage is taken from the set. Horizontal and vertical hold controls and a vertical size control are provided. The slave oscillator can be operated free-running or it can be controlled by sync signals from the receiver. To use the probe, you simply open the lead connecting the receiver oscillator to the output stage and clip the proper lead from the probe to the input of the output stage."

"That would certainly show up anything wrong with the oscillator in a hurry," Barney observed.

"Yes, and by being able to pick off the 'B-plus' and the sync input at different places, you can tell a lot about other stages, too. But let's see how smart you are. What do you suppose this probe, called 'Video Master,' is supposed to do?"

"I give up. The fellow who named these probes is too subtle for me."

"It's a high-gain tuned stage operating into a demodulator. I'd call it a TV i.f. signal tracer myself. Two calibrated tuning ranges are available that tune through the 20 mc. and 40 mc. i.f. frequencies. The output of the probe feeds into a scope and permits you to view the composite signal right from where it comes out of the tuner clear to the input of the video detector. That allows you to spot a defective stage immediately. By moving the i.f. carrier frequency around with the fine tuning and then picking it off at the proper point with the probe, you can tell where any stage is peaked. In fact, the manufacturer insists you can use the probe to align the i.f. portion of a set completely, even to setting the traps, by following instructions."

"I'll not call him a liar," Barney offered generously. "I've used a tuned probe some in radio servicing and know how versatile it can be."

"Well, we've got to get to work," Mac said as he laid the little probe down on the bench, "but I'd like for you to take these along with you on your house calls next week—after you have played around with them here until you know what they will do—and see how much use you find for them. When you are in a customer's home, reach for one of the probes only if you feel it will give you the information you want faster and better than the other instruments you have with you. Try to decide if one of the probes can take the place of two or three other instruments you normally take with you. At the end of the week let me know what you think. I'll buy any of the probes you say you would like to have."

"OK," Barney agreed; "and I'll keep in mind what you have told me about not getting 'instrument happy' and buying every new service tool that comes out. But I can tell you right now, that no matter how these particular probes turn out, I'm glad to see manufacturers doing some thinking about our problems and coming out with compact, lightweight, specialized service instruments that will help in diagnosing and correcting trouble in the home. That tool box gets pretty doggone heavy by the end of the day and having to scamper up and down several flights of stairs to get other stuff from the truck is no snap, either. A brain that can pack a complete transistor radio into a few cubic inches ought to be able to bring out finer, more compact service instruments; and these probes look to me like a step in the right direction!" —30—

DECEMBER 3-5

Eastern Joint Computer Conference. Sponsored by IRE, PGEC, AIEE, and ACM. Bellevue-Stratford Hotel, Philadelphia. Program information from Dr. F. M. Verzuh, MIT Computation Center, Cambridge 39, Mass.

Second National Symposium on Global Communications. Sponsored by IRE, PGCS, and AIEE. Colonial Inn Desert Ranch, St. Petersburg Beach, Fla. Merle R. Donaldson, Electronic Communications Inc., 1501—72nd St., N., St. Petersburg, Fla., program chairman.

DECEMBER 4-5

PGVC Annual Meeting. Sponsored by IRE-PGVC. Hotel Sherman, Chicago. K. V. Glentzer, Illinois Bell Telephone Co., 208 W. Washington St., Chicago, for program information.

DECEMBER 9-11

Mid-America Electronics Convention. Sponsored by Kansas City Section of IRE. Municipal Auditorium, Kansas City, Mo. Wilbert O'Neal, The Vendo Co., 7400 E. 12th, Kansas City, will supply information on program.

JANUARY 12-14, 1959

Fifth National Symposium on Reliability & Quality Control. Sponsored by IRE, PGRQC, AIEE, ASQC, and EIA. Bellevue-Stratford Hotel, Philadelphia. W. T. Sumerlin, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa., in charge of program.

Tube Makers Fight Counterfeiting

EIA adopts code to hinder processing of old tubes.

ON THE RECOMMENDATION of its Tube and Semiconductor Division, the Board of Directors of the Electronic Industries Association has adopted a code of ethics to counteract tube counterfeiting and related practices throughout the industry. The opportunity for making various uses of old tubes, EIA points out, arises from the availability of hundreds of thousands of defective, out-of-warranty receiving tubes.

Counterfeiters arrange to obtain and "wash" these to remove identifying marks that would indicate original manufacturer and warranty date code. The tubes are then imprinted with new, spurious markings to take advantage of existing manufacturer warranties and are used to obtain new tubes from these sources. In some cases the discarded tubes are remarked so that they can be sold again on the open market.

First of the five points covered by the code is a pledge of cooperation on the part of the manufacturer with law-enforcement authorities in the detection, investigation, and prosecution of those engaged in the improper use of discarded tubes. The second point covers education of interested segments of the electronic industry to the dangers involved. This includes assistance in exposing fraudulent tube operations and emphasizing the importance of the problem to distributors, set manufacturers, and service technicians.

In addition tube manufacturers should attempt to put into effect the recommendations of grand juries and other public bodies wherever possible. Inasmuch as there is no known method of successfully renewing worn-out tubes, the code further states, manufacturers must continue present efforts to dry up the supply of discarded ones by encouraging their destruction by receiver manufacturers and on all levels of distribution.

Final point in the code deals with tube warranties. The EIA feels that it is unfair for the industry to dictate a uniform policy to be followed by all tube manufacturers. However, these programs should be established and administered in such a way as to insure against the re-introduction of discarded tubes into the market. It is felt that this can be done without infringement of each producer's right to establish his own system.

In cooperation with the spirit of this code, RADIO & TV NEWS will continue its long established policy of carefully scrutinizing all tube advertising to ascertain that the offered merchandise is correctly and legally identified. —30—

ELECTRONIC TYPESETTER TO BE MARKETED

Prepares type more than three times as fast as normal means.

THE *Wall Street Journal* and *RCA* have announced an agreement under which *RCA* will produce and market an electronic typesetting machine, developed by *Dow Jones & Co., Inc.*, and capable of preparing metal type more than three times as fast as conventional methods. The pact includes not only the "Electro-Typesetter" but also tape editing and collation apparatus, and a strip labeler for addressing newspapers, periodicals, and other printed matter. The strip labeler can print addresses on a mailing strip at the rate of 15,000 an hour—two to three times as fast as devices now in use. Earlier this year, *RCA* announced the development of a transistorized newspaper counter which is now in use at *The Detroit News*. All these devices are designed to help produce papers more efficiently as well as to cut some of the costs of production.

The "Electro-Typesetter," is controlled by a perforated tape produced on conventional perforator machines using a typewriter-like keyboard. When an operator taps a key, the machine cuts holes in a paper tape. This tape, in turn, is fed into a tape reading device which transmits electrical signals to the type casting machine. When a sufficient number of characters have been selected to complete a line of type, a signal perforated in the tape instructs the machine to cast the characters into a line of lead type. New versions of the machine may be operated automatically as well as manually. In this case, the keyboard is not used at all. Instead, either electrical or mechanical devices are substituted for the keyboard operator's fingers.

The counting system mentioned above can total simultaneously the output of forty different production, processing, and packaging operations, counting up to 120,000 units per minute. The system can be given a dialed order for the exact quantities desired. When that amount has been recorded, an alarm system goes into operation, and the presses or conveyers are stopped automatically. The operation permits a newspaper not only to count precisely the number of papers printed, but to limit production and prevent costly over-runs or premature press shutdowns.

The system's high-speed counting ability stems from its built-in electronic memory system, which stores counting signals and then releases them in the rapid sequence required for quick totaling. —30—

Square-Wave Applications

(*Continued from page 70*)

will be broken into a dashed line, with the number of dashes within one cycle equal to the number of square-wave cycles occurring during the same time. To determine the frequency of the unknown signal, simply divide the frequency of the square-wave generator by the number of dashes appearing during one cycle of the unknown signal. In Fig. 8D, the frequency of the square-wave generator would be divided by 12.

Assuming ten dashes to be the optimum number that may be readily distinguished and counted, it becomes possible to measure, easily, unknown signals with a frequency one-tenth the lowest frequency of the square-wave generator. Accuracy of the technique depends on the care taken in making the observation and the accuracy and stability of the square-wave generator used.

As a marker generator, the square-wave generator may be used to check short time intervals, for determining the rise or decay time of a transient pulse, and in similar applications. The connections are essentially as used for blanking purposes and the technique is similar. However, to determine the rise time, decay time, or pulse duration of a complex signal, it becomes necessary to convert the square-wave frequency into terms of microseconds (or milliseconds) of time duration. This can be done by dividing the square-wave frequency (in pulses-per-second) into one million (for microseconds) or one thousand (for milliseconds).

Thus, a 500,000 pps square-wave signal has a time duration of two microseconds. When used for blanking the trace of a CRO, the trace is visible for one microsecond (half-cycle). From this, if the pulse being checked rises from 10% to 90% of its peak value during the unblanked interval, its rise time is 1 microsecond. If this happens during half the unblanked interval, the rise time is .5 microsecond. By using the graph screen of the CRO as a scale, it is possible to make quite accurate estimates in terms of small fractions of a microsecond.

Conclusion

As we have seen, the applications of the square-wave generator are almost unlimited. In this article we have attempted to cover only the simpler applications, requiring little additional equipment. By using additional equipment and more complex accessory circuits, it is possible to extend the applications beyond those covered here.

The square-wave generator is rapidly becoming an instrument as useful and as important as the v.t.v.m., CRO, and sine-wave generator to the experimenter, development laboratory engineer and service technician. —30—

Amateur Receiver Kit

(*Continued from page 65*)

6BJ7 triple diode and to a 6CS6 pentagrid tube. The 6BJ7 is used for AM detection, delayed a.v.c., and automatic noise limiting. The 6CS6 is a combined product detector and b.f.o. tube used for SSB and c.w. signals. Diode detector output is applied to half of a 12AT7, whose cathode current is measured by a calibrated "S" meter. The other half of the 12AT7 takes audio from either the diode detector or the product detector, amplifies it, and then applies it to a 6AQ5 audio output tube. This tube's output is connected to a speaker or to a pair of phones.

Power supply for the receiver is a conventional full-wave rectifier using a 5V4 whose output feeds an *LC* filter. Regulated voltage, obtained from an 0A2, is applied to the 100 kc. oscillator, the high-frequency oscillator, the product detector, the "S" meter amplifier, and the gain control circuits.

Alignment and Performance

Even though the receiver worked "the first time" without alignment, in order to get the top performance of which the set is capable, a careful alignment must be done. Fortunately this can be done very accurately without using any equipment outside the receiver itself. After all, the set has its own crystal oscillators that can be used as signal generators, and it has its own tuning meter that can be used as an output indicator.

The receiver is first temporarily shifted (by means of added preset mixer and oscillator trimmers) to 10 mc. so that WWV may be picked up. The 100 kc. crystal oscillator is then carefully trimmed so that its 100th harmonic zero-beats with WWV. Then the second harmonic of the 50 kc. b.f.o. is zeroed against the 100 kc. crystal oscillator. Next, the 50 kc. i.f. circuits are peaked, using the b.f.o. as signal generator. Now with these circuits accurately aligned, with the front end previously aligned by the manufacturer, and with crystal oscillators feeding the second mixer, it is only necessary to peak up the 1682 kc. i.f. circuits for a maximum reading on the "S"-meter.

We found it necessary to touch up front end adjustments for the 10-, 15-, and 20-meter bands in order to center the range of the oscillator calibration control. This may or may not be necessary in all cases.

After the complete alignment, we were able to just sit back and enjoy the fine performance of the set. It operated like a charm with all controls performing exactly as they should. The set has excellent sensitivity and selectivity and the rock-like stability needed for SSB reception.

To sum up then: the "Mohawk" is a lot of work to build, but you get a lot of receiver for your work. In short, it's well worth the effort. —30—

Electronic Level Indicators

(*Continued from page 43*)

swings, however, the effective resistance between cathode and grid becomes infinite since there is no current flow between these tube elements. This changing load resistance would cause severe distortion if it were not for the intervening resistance between the signal and the tube, R_1 and R_2 respectively in Figs. 2 and 3.

A similar thing happens when a neon lamp is employed as an indicator. The effective resistance of the lamp changes from about 100,000 ohms when it is fired to infinity when it is extinguished. Again a series resistor between signal and lamp is necessary to prevent the changing resistance from loading down the audio source. R_1 serves this purpose in Fig. 4, and R_1 and R_2 in the circuit of Fig. 5.

Preventing Bias Pickup

Ordinarily it is of fundamental importance that the bias current supplied to the record head does not reach the record-level indicator, thereby causing the latter to give a false reading. In Fig. 2, bias current is filtered out by C_2 in conjunction with R_1 and R_2. In Fig. 3, filtering is essentially due to C_2 in conjunction with R_2. In Fig. 4, filtering is accomplished by C_2 and R_1. In Fig. 5, we have the exceptional case where bias current is deliberately allowed to reach the neon lamps, as will be further discussed below.

One of the means employed to minimize the amount of bias current reaching the record-level indicator is to pick off the audio signal prior to the stage that drives the record head. Thus the tube that supplies current to the head serves as a buffer between the bias current and the indicator.

Adjustment

If the record-level indicator is not fairly accurate in its indications, serious over-recording or serious under-recording may result. Generally, tape recorders employing an electronic indicator do not provide means for readily adjusting the indicator to correspond to maximum permissible recording level. However, Fig. 5 is an exception. The neon lamps in this circuit are fired by a combination of the audio signal and a certain amount of bias current. The variable capacitors regulate the amount of bias current reaching the lamps and thereby afford a means of adjusting the level at which they ignite.

If adjustments are desired in the circuits of Figs. 2, 3, and 4, one could change values in the voltage-divider networks. In Fig. 2, one could change R_1. In Fig. 3, one could change R_2, although this would also require corresponding changes in C_2 and R_2 to preserve the "floating action" time-constants of the circuit. In Fig. 4, R_2 or R_3 could be changed to place a different "bias" voltage on the lamp. –30–

New Look in TV Service

(Continued from page 54)

tion in the size of service organizations. The average shop now employs about three people during peak seasons as compared to the five which was "average" about four years ago. The most successful service businesses seem to be those that employ three men, including the owner, and a competent "girl Friday" who handles the phone calls and most of the shop traffic. While this currently "ideal" business depends upon service for its primary income, it retails TV sets and some hi-fi components.

In the process of mental transition, service dealers in the mass are gradually moving toward the recognition of their responsibilities and obligations as an important part of the business segment of our economic system. For many years, the service industry had a "persecution complex." In the eyes of service dealers, everyone was against them. They were misunderstood by the public, double-crossed by their parts distributors, and un-wanted step-children of the set and component manufacturers.

The transition process, which started with the formation of business associations for service dealers, has been gradually bringing about recognition of the fact that many of the troubles that beset independent service are due to the acts of omission and commission on the part of service dealers themselves. As it becomes apparent to association members that they have both the responsibility and the tools for solving some of the industry's most pressing problems, they set the wheels in motion to do something about it. The service industry is fast losing its "persecution complex."

While practically all of the aggressive associations are under the leadership of seasoned veterans, they get a lot of their driving force from the younger generation of service dealers who are determined to build electronic service into one of the country's most stable and respected industries. —30—

TV SERVICE TECHNICIAN ALL-AMERICAN AWARDS

THREE MEN of national prominence have been chosen as judges in General Electric's second annual All-American Awards for public service by TV repairmen. They are Sen. John Sparkman, chairman of the U.S. Senate Small Business Committee; Bennett Cerf, TV panelist and head of Random House publishing firm; and Charles Shearer, president of the National Junior Chamber of Commerce.

In announcing the judges, Irvine D. Daniels, chairman of the 1958 All-American Award committee, said TV technicians are "trail-blazing pioneers whose work will lead to all-around electronic home servicing in the future."

The judges will select the ten technicians who perform the most outstanding public or community service. Trophies and prizes of $500 will be presented to the winners. —30—

SOUND ON TAPE

By BERT WHYTE

AT THE recent New York High Fidelity Show, one thing was conspicuous by its absence and that was the sign of any production models of the 4-channel, 3¾-ips tape machines. This was true of the proposed cartridge types and, for the most part, of the reel types as well. Of course, *Ampex* had its unit, which will play either the present 7½-ips, two-channel or the new 4-channel stuff, on display. But let's face the fact that not everybody can afford an *Ampex!* Of 4-channel tapes themselves, there were a few examples about, mostly experimental stuff. Through a decent rig some of them sounded quite acceptable and some were just awful. In all cases, I heard nothing which can approach the quality of our present 7½-ips tapes.

Where were the new machines and the 4-channel tapes? From what I can gather the reasons for the delay are manifold—production difficulties is one, temporary shelving because of pre-occupation with the stereo disc is another, and one hard to beat reason . . . so say some manufacturers . . . "we won't produce 4-channel tapes until there are sufficient machines to constitute a market" . . . "we won't produce 4-channel tape machines until tapes for them are produced in quantity." In other words it's the old "chicken and the egg" routine and it won't be resolved until somebody with enough courage . . . and a lot of loot . . . decides to take a chance.

In the meanwhile, despite the stereo disc, there are a few stirrings of interest in our present 7½-ips market. Some tapes are still being produced and other companies have decided to resume production. I wish I were at liberty to tell you of a development which will really set the tape world in an uproar. It is quite sensational, but I've been sworn to secrecy. I can say this though . . . anyone who has thought of holding funeral services for 7½-ips tape is not only premature, but ill-advised. After a long drought a few tapes have trickled in and of fine quality too!

RAVEL
BOLERO
BIZET
L'ARLESIENNE SUITE #2
Detroit Symphony Orchestra conducted by Paul Paray. Mercury MCS5-50. Price $11.95.

Since the *Mercury* stereo disc of this "Bolero" arrived at the same time (it is reviewed in this month's record column) it affords a fine opportunity for comparison. The stereo disc was of unusually high quality, one of the best that has been issued, so the comparison is in no way unfair.

Well, despite all the attractiveness of the disc, it simply is not in the same league with the tape. In terms of dynamic range and especially frequency response, lack of distortion, absence of spurious modulations and, need I say, infinitely superior interchannel separation with subsequent better positioning of instruments, directivity, depth perspective, and the big, full, bright over-all, sound, it is virtually no contest.

I would ask the wild-eyed devotees of the disc and those who would eliminate 7½-ips tape to listen and compare. If they were honest and unbiased, their only conclusion would be that the tape is still in a class by itself when it comes to stereo. And I still say that there are plenty of discriminating audiophiles who want this superior quality in spite of the price differential. The "L'Arlesienne Suite" is not on the disc so is an added bonus of listening pleasure on the tape. As noted in the record column, Paray deals with this music particularly effectively. I rest my case here, but urge you once again to make this comparison if at all possible . . . it's an eye-opener!

GERSHWIN
RHAPSODY IN BLUE
Eugene List, pianist, with Eastman Rochester Symphony Orchestra conducted by Howard Hanson. Mercury MWS5-47. Price $6.95.

Of the several stereo tape versions that have appeared of this most popular of all Gershwin works, this is quite easily the best. List is not as perceptive as he might be, but his performance is strong, honest, and workmanlike. His little inadequacies are made up for by the sound on this tape which is extremely brilliant, well projected, with excellent directivity and fairly good depth sense.

The piano stays just left of center where it is supposed to be and doesn't wander from left to right speaker. Extremely wide dynamics here and broad frequency response. The piano reproduces beautifully with sharp, clean sound—a result of fine transient response and over-all low distortion. Dr. Hanson lends good support to List and, as always, his orchestra responds willingly to his urgings. Here, again, the stereo disc of this is available and gives you still another area for comparison.

MAX ROACH PLUS FOUR
Max Roach and his orchestra. Mercury MVS3-12. Price $7.95.

This was an outstanding disc in its monaural version and it's strictly sensational here in the stereo medium. As mentioned in the monaural review, this is characterized by Roach's terrific hard-driving style and the excellence of his sidemen. In a program consisting mostly of originals, Max churns up quite a storm with his drums and the stereo and the sound is great.

This is a multi-mix job done with good taste and just the right spread and fill—making for very natural sounding stereo. The over-all sound is very big and brilliant and is projected well forward. If a stereo disc of this is issued, as I am sure it will be, all other things being equal I don't think the comparison will be quite as drastic as in the case of classical material, mostly due to the greatly reduced scoring and scale of the music. Yet I think there will, even in this instance, be enough of a difference to make it more worthwhile to some people than the less costly disc. In any case this is a fine stereo tape for "cooler cats." —30—

Major Gilbert, engineer at Hoffman Electronics Corp., and operator of amateur radio station K6LMW, calls in two other ham stations 2000 miles away with equipment powered entirely by energy from the sun. The transmitter used operates on the 10-meter band and has an output of about 75 milliwatts. The power supply for the call was a bank of 72 of the half-dollar-size Hoffman silicon solar cells.

FRAME-GRID TUBES

A new brochure containing a detailed description of the advanced frame-grid tube entitled, *"Amperex* 'PQ' (premium quality) Reliable Frame-Grid Tubes," has been announced by *Amperex Electronic Corp.*, 230 Duffy Ave., Hicksville, Long Island, N. Y.

Contained in the brochure is a detailed description of what the frame-grid is, how it is made, specific military and industrial applications of frame-grid tubes, and a comprehensive working definition of tube life and reliability. Also included are general descriptions of the firm's three new frame-grid tubes for military systems requirements and industrial applications: the type 5847, type 6688, and type 6922. The first is a high-gain miniature pentode designed for broadband amplifier applications where a high figure of merit is required; the second is for similar applications but with improved base pin arrangement and higher transconductance; and the third is a twin-triode with separate cathodes.

Free copies of this booklet and detailed specifications on the three tubes may be obtained by writing to the company's advertising department at the above-mentioned address.

RADIO SHACK FLYER

Radio Shack Corp., 167 Washington St., Boston 3, Mass. has made available its new flyer, complete with mail-order blank.

This 24-page catalogue, No. 67, features the firm's "Expansion Sale Specials" which include such items as portable phonographs, electronic flashes, cameras, hi-fi components, and many other items.

Write direct to the company for a copy of this flyer.

"AMPROBE" SALES CATALOGUE

Pyramid Instrument Corporation, 630 Merrick Rd., Lynbrook, N. Y. has issued an all-inclusive sales catalogue, No. A-583, that delineates complete information on its "Amprobe" line.

Model numbers, specifications, applications, and price lists are included in the brochure.

The booklet may be obtained by writing to the firm in care of the "Amprobe" Division at the above address.

INDUSTRIAL TUBE CATALOGUES

Four new catalogues describing the *CBS-Hytron* expanded industrial tube line present technical data and application information on over 400 types

of power tubes, gas tubes, and power rectifiers, as well as military and special-purpose tubes, and phototubes and photocells.

Bulletin E-290T includes industrial power triodes and tetrodes, pentodes and beam tubes, with information on construction, ratings, applications and basing. Gas diodes, grid-controlled gas tubes, and power rectifiers are described in Bulletin E-290C.

Bulletin E-290S covers military and special-purpose tubes and Bulletin E-290P embraces vacuum and gas phototubes and photoconductive cells.

These catalogues are obtainable from the firm's distributors or from its Advertising Service, Newburyport, Mass. The bulletin numbers should be specified for each catalogue requested.

COLUMBIA WIRE SUPPLEMENT

Columbia Wire & Supply Co., 2850 W. Irving Park Road, Chicago 18, Ill. announces a new 4-page supplement to its catalogue No. 107. Many new items in the wire and cable field have been added to this new brochure.

Copies of both the catalogue and supplement can be obtained by writing directly to the firm.

P-N-P TRANSISTOR LISTING

Workman TV Inc., 309 Queen Anne Road, Teaneck, N. J. has issued a master cross-reference sheet and price list on *p-n-p* transistors.

The sheet carries information on types, suggested list and dealer prices, and an interchangeability guide. This comprehensive listing may be obtained direct from the company upon request. Ask for Form CS41.

ELECTRONIC COMPONENT BULLETIN

Richard Electrocraft, Inc., 4432 N. Kedzie Ave., Chicago, Ill. is offering a new 12-page bulletin, No. 558, giving complete information on its line of electronic components.

Included are standard and miniature-sized plugs, phono plugs and jacks, push-button switches, stack assemblies, and standard and miniature connectors, among other components.

All parts are illustrated and line drawings show complete construction details. Tables list sizes and types available.

R/C SYSTEM CATALOGUE

Perma-Power Company's radio control systems for industrial, commercial, and residential uses are carefully described and illustrated in a new color catalogue, B-138.

Complete information, including technical data and prices, are given so that most applications can be completely specified from the brochure.

For complete information and this new catalogue, write directly to the firm at 3100 N. Elston Ave., Chicago 18, Illinois.

POWER SUPPLY KIT FOLDERS

Two 4-page folders covering the uses and specifications of two power supply kits have been announced by *Electro Products Labs.*, 4500 N. Ravenswood Ave., Chicago 40, Ill.

The folders cover Models KPS-2 and K-612T, both filtered d.c. power supply kits.

These illustrated brochures are available from the company by writing to the attention R. C. Crossley.

"PRINTED CIRCUIT SOLDERING"

Anchor Metal Company, Inc. has published detailed instructions on "Printed Circuit Soldering" that are of particular interest to design and production supervisors.

The brochure includes a general discussion of printed circuitry, an explanation of proper solder composition, flux requirements, solder pot considerations, and a step-by-step clarification of the techniques of dip soldering.

Copies may be obtained by writing to Herbert Drapkin at the company, 966 Meeker Ave., Brooklyn 22, N. Y.

LAFAYETTE 1959 CATALOGUE

Lafayette Radio has released its 1959 general catalogue of electronic parts and equipment, including a complete line of stereo high-fidelity components.

The new 260-page catalogue features 64 pages in 2-color rotogravure and 4-color covers and is 8" x 10" in page size. Highlights include a comprehensive listing of the newest stereophonic sound equipment and complete stereo systems, including components for conversion of conventional hi-fi systems to stereophonic sound. A full presentation of radio and TV parts, transistor kits and miniaturized components, antennas and installation accessories, amateur gear, tools, technical books, and many other items is featured.

This new catalogue, No. 590, is available free upon request. Write to the company at 165-08 Liberty Avenue, Jamaica 33, N. Y.

CAPACITOR MANUAL

Sprague Products Company announces the ninth edition of its popular "TV Replacement Capacitor Manual."

The current edition gives complete, up-to-date listings of all replacement capacitors used in TV sets manufactured from 1946 through 1957. Each manufacturer is listed alphabetically with original part numbers in numerical order and cross-referenced to the firm's replacements. Brief descriptions of the parts, complete with prices, are also included.

Copies of the 56-page manual are available at no charge from the company's distributors or by sending 10¢ for Manual K-103 to the firm at 51 Marshall St., North Adams, Mass.

RTTA GUIDEBOOK

Radio-Television Training Association has a new catalogue called "How To Make Money in Radio, Television, Electronics, and Color TV".

An innovation in the presentation of catalogue material is achieved with a feature dubbed "A Trip Around *RTTA*" —with Tommy Drake. Tommy Drake is actually a student and he performs the job of personally conducting the

reader on an "excursion" of the school.

The 16-page booklet is interestingly illustrated throughout. It contains a description of the school's courses as well as a listing of all lessons for each course. A double-page spread is devoted to a display of kits students build and keep as part of their training. Another highlight is a Career Opportunities Listing. It gives a breakdown of positions and duties, qualifications, training, and salary range of each job.

Free copies of the catalogue are available by writing to *RTTA*, % Dept. PR-3, 52 E. 19th St., N.Y.C.

NEW BOOK CATALOGUE

D. Van Nostrand Company, Inc. has a new catalogue which describes some 1000 recent and published works in engineering, chemistry, electronics, aeronautics, physics, nuclear science, mechanics, biology, mathematics, technical dictionaries, and many other specialties.

The 144-page booklet is available from the company, 120 Alexander St., Princeton, New Jersey.

NEW EIA STANDARDS

Electronic Industries Association has released five new recommended Standards. They are:

RS-165-A, Ceramic Dielectric Capacitors. Classes 1 & 2—1000-7500 Volt Rating, price 80¢.

RS-207, Television Tuner Performance Presentation and Measurement, price 25¢.

RS-210, Terminating and Signaling Equipment for Microwave Communications Systems, Part 1, price $1.10.

RS-211, Dimensional Characteristics of Phonograph Records for Home Use —78 rpm, 45 rpm, 33⅓ rpm, price 60¢.

RS-212, Numbering of Electrodes and Designation of Units in Electron Tubes, price 25¢.

These Standards are available from the Association's Engineering Dept., 11 W. 42nd Street, New York 36, N. Y.

"FLIP CHART KIT"

Seco Manufacturing Co., 5015 Penn Avenue South, Minneapolis 19, Minn. is offering an up-to-date "Flip Chart Kit" for its Model 107 tube tester.

The chart includes a complete set of cards and a new index panel. Data on all tubes, including late releases, is provided.

This information is available by writing direct to the company.

1959 ALLIED CATALOGUE

Allied Radio Corp. has released its 1959 general catalogue of electronic parts and equipment. This new 452-page book lists over 32,000 items.

Among the many items included are the firm's line of "Knight-Kits," radio amateur kits, industrial equipment, high-fidelity, technical books, a TV section which includes antennas, and a complete listing of the newest stereophonic sound equipment.

Highlighting the audio section are details on complete stereo systems, leading types of individual stereo units, recording and playback decks, and add-on components for conversion of conventional systems to stereo. Also listed is a special selection of new stereo records as well as a wide choice of recorded stereo tapes.

The catalogue is available free from the firm, 100 N. Western Ave., Chicago 80, Ill.

TRANSISTORIZED ELECTRONIC CIRCUITS

Free brochures outlining transistorized electronic circuits of interest to the hobbyist, engineer, and student are being made available by the semiconductor division of *Motorola Inc.*

The brochures provide some unique as well as practical applications of transistorized circuits.

The booklets are available free upon request from distributors of the firm's semiconductor products or by writing to the company direct at 5005 East McDowell Road, Phoenix, Arizona.

CENTRALAB "COMPENTROL"

A revised edition of the *Centralab* booklet on the "Compentrol," compensated volume control for high-fidelity, is now available.

This 20-page booklet is profusely illustrated and contains simple installation instructions for the unit. It is available without charge by writing to the firm, a division of *Globe-Union, Inc.*, 900 E. Keefe Avenue, Milwaukee 1, Wisconsin. —30—

Receiving & Recording Satellite Signals

By **FRANK K. DEARBORN**
Air Force Cambridge Research Center

Notes for hams and SWL's on the proper way to tape signals so as to be of greatest value.

THE response of amateurs and others to the request for measurements of the U. S. satellite signals has been gratifying and, as was expected, has provided valuable information. The author would like to review, very briefly, the two major fields of measurements that may be undertaken by independent investigators such as amateurs and SWL's.

The first field is that of Doppler measurement which requires the use of receiving equipment of a high degree of frequency stability. It must not be subject to either local or beat oscillator drift or a.g.c. frequency pulling effects. These measurements, then, require the use of a crystal-controlled heterodyne oscillator at the carrier frequency (or a subharmonic thereof) or a receiver whose internal construction provides a comparable stability. These measurements can and are being made by various amateurs and the data obtained will be of value in many cases.

The second major contribution is the direct recording of telemetry signals from the satellite transmitters. We have had occasion to request the loan of quite a few amateur tape recordings of satellite telemetry signals which were recorded at what was considered to be critical periods. It has been noted that in all cases they suffer from one particular defect—the use of a heterodyne oscillator either at the carrier or intermediate frequency. It is likely in most cases that the heterodyne oscillator was used for Doppler measurement purposes.

Simultaneous Doppler measurements and telemetry reception by the same receiver tend to be incompatible. Assuming an amplitude-modulated transmission, two reasons may be advanced to support this statement:

1. A beat oscillator produces its strongest output signal by heterodyning against the carrier frequency itself. The fact that this frequency varies because of receiver instability and/or Doppler shift makes it exceedingly difficult to remove with a filter. If the heterodyne falls within a desired telemetry channel and close to the telemetered frequency, the data becomes almost impossible to read. This is generally true at least part of the time.

2. The best oscillator also heterodynes against the sideband components produced by the telemetry frequencies. As these frequencies are rather closely spaced to the carrier frequency and each other, the result is the generation of at least two complete sets of spurious frequencies plus the original beat frequency, all of which are continuously changing from Doppler shift and/or receiver instability.

If, in addition to this, harmonic distortion is present within the receiver or tape recorder, then to add to the existing woes a second order collection of intermodulation products appear in the output. The result is similar to the "search for a needle in the haystack"

Author is shown at the right using data reduction gear to read satellite signals.

with the needle being periodically moved.

Having rather thoroughly covered the dark side of the picture a few positive thoughts on the subject might be appropriate. A few suggestions are given to minimize the difficulties that have arisen.

Tuning Procedures

Receiver tuning procedures may be somewhat different depending upon the type of modulation used in the transmitter. If the transmitter is frequency modulated, the receiver should be centered on the carrier as in standard tuning procedures, either by using the telemetered signal for tuning or, preferably, a stable reference oscillator whose frequency calibration is accurately known.

In the case of the amplitude-modulated transmission, two approaches are possible. First, the receiver may be adjusted so that its bandwidth is sufficient to receive both sets of sidebands with little attenuation. An alternate procedure would be to operate the receiver more or less as a single-sideband system with a bandpass adequate to accept the carrier frequency plus one set of sidebands with due allowance for Doppler shift. In either case, crystal filter operation of the receiver is not advisable unless the filter rejection peak is well outside the carrier or highest sideband frequency.

If at all possible a crystal reference oscillator is advisable for tuning purposes. No adjustments whatsoever should be made to the receiving equipment during a satellite pass with the possible exception of a quick tuning check during the maximum signal condition if a good reference oscillator is not available. One reason for this is that certain types of data reading equipment, for instance a wave analyzer, may be sensitive to changes in the noise spectrum as caused, for example, by receiver tuning.

In many cases telemetry signals which may not be at all audible may be translated quite readily. If the presence of the carrier is indicated by an increase in the receiver noise, valid telemetering information may be present and recording should be started at this time. Assuming that the receiving system is properly adjusted to pass the carrier and sideband components, the audible signal-to-noise ratio is determined by these adjustments. This is not the signal-to-noise ratio, however, as viewed from the standpoint of an individual telemetry channel which is much narrower than that of the receiving system as a whole. As a result, the signal-to-noise ratio of the individual telemetry channel is improved by a factor equal to the total receiver bandwidth divided by the telemetry filter bandwidth. This improvement factor, in itself, is adequate to make an apparently useless signal easily readable. In addition, it is not difficult to read at least 20 db below the noise existing within the filter bandwidth by employing a technique no more complex than

an oscilloscope whose vertical input is the telemetered signal and whose horizontal input is an external audio oscillator. The technique, of course, is that of frequency measurement of the subcarrier oscillator by zero-beating the reference oscillator. The approach is both simple and reliable and has been used in reading many data tapes. This method may be satisfactorily employed even without the use of band separation filters for the various telemetry channels.

Recording Time

The final data interpretation from both amateur and professional tape recordings is highly dependent upon an accurate knowledge of the time at which the recordings were made. The signal strength at each receiving station varies greatly between the different satellite passes as well as during a single pass. It is necessary, therefore, to analyze the data from several stations which may be receiving the signal at approximately the same time. If the recorded time is not known for each station, the data may be incomplete, confusing, or even worthless. In general, this requirement has been recognized by amateurs who have participated in this program.

Various methods of recording time have been used by amateurs. One amateur handled the problem by switching from telemetered data to WWV for both the five-minute voice and code announcements with a few seconds break for each one-minute mark. This method, while excellent, generally requires the use of a second receiver. An alternate method that should be quite good would be the accurate setting of a clock or watch to WWV before the satellite pass and voice recording the time for each minute- and five-minute period. A third possibility would be the recording of time in code by either an accurate 400-cycle oscillator or the 60-cycle a.c. line. In either case, the start of the minute would be indicated by a five- to ten-second dash following the code announcement. The use of either an accurate 400-cycle or 60-cycle frequency has the additional merit of providing a check on the exact speed of the recording and reproducing equipment. A worthwhile modification of the idea would be to continuously record the selected tone at a low level and amplitude key its level for code recording. If possible, the time error should be held to less than one second.

The foregoing suggestions are not meant to discourage the efforts of those who have undertaken measurements of the satellite transmissions but merely to point out possible improvements which might be made in the receiving and recording of data.

The author wishes to express his appreciation to Messrs. N. W. Mathews of the Naval Research Laboratory and L. N. Cormier of the National Academy of Sciences for their comments and suggestions on the preparation of this article.

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"SERVICING HI-FI AND ASSOCIATED AUDIO EQUIPMENT" compiled and published by *Howard W. Sams & Co., Inc.*, Indianapolis. 153 and 148 pages (Vols. 1 and 2 respectively). Price $2.95 each. Soft cover.

This two-volume "library" of servicing information and schematic data should prove a decided boon to technicians involved in keeping hi-fi equipment operating at peak performance. Each item covered receives "Photofact" treatment with schematic, parts list, voltage and resistance measurements, in addition to complete service dope.

Volume 1 covers twenty-six models of 1956-1958 equipment including power amplifiers, preamps, AM-FM receivers and tuners, and p.a. amplifiers. A special section covers planning, installation, and maintenance of home music systems.

The second volume provides similar coverage on twenty-seven models of 1956-1958 equipment plus a special section on the planning and installation of stereo music systems for the home. A cumulative index covers both volumes.

Serious audiophiles with a good technical background will find these volumes as useful as will the man whose business it is to keep audio gear up to professional standards.

* * *

"CLOSED-CIRCUIT TELEVISION SYSTEMS" prepared by Government Service Department, RCA Service Company. Published by *Radio Corporation of America*, Camden, N. J. 348 pages. Price $4.50.

This handbook has been prepared for the information and enlightenment of engineers, industrialists, and technicians who are concerned with the installation, servicing, and planning of closed-circuit television projects.

The text material is divided into three major sections dealing with monochrome systems, color systems, and pertinent data which applies to both types of transmission. Book 1, dealing with black-and-white installations, covers a general introduction to the subject, fundamentals and techniques of closed-circuit TV, factors to be considered in the selection of CCTV equipment, general systems planning, and system planning and specific applications.

Book 2, on color systems, follows much the same informational pattern as for the monochrome systems but, of course, applies to the tinted transmissions. The "Addenda" section includes the index for the main body of the text and two sections on educational TV and industrial TV. The former in-

cludes medical applications and general educational uses. The section on industrial applications covers CCTV in the railroad industry, the aircraft, metals, paper, and power fields, and in commercial and business houses.

The text is lavishly illustrated with line drawings, graphs, scope patterns, and photographs of actual equipment and installations. Those involved in this burgeoning field will find this handbook especially valuable as a reference source as well as a practical guidebook.

* * *

"MAGNETIC RECORDING TECHNIQUES" by W. Earl Stewart. Published by *McGraw-Hill Book Company*, New York, 268 pages. Price $8.50.

This is an engineering text for those directly concerned with magnetic recording methods and devices as used in audio, television, communications, automation, computers, and related fields.

The text is divided into six chapters and a 9-part appendix. The first chapter deals with the basic magnetic recording processes with the balance of the book covering magnetic recording media, the reproducing process, magnetic recording mechanisms, ferromagnetism, and magnetic recording standards. The appendices cover self-demagnetizing formula, the influence of head and tape constants on the signal recorded on a magnetic tape, accidental-printing formulas, reproduction of signals recorded on magnetic tape, gap-loss formula, spacing and thickness loss formula, magnetic loop tracer, definitions of magnetic quantities, and conversion factors.

Although the emphasis is on the industrial applications of magnetic recording rather than the home-entertainment aspects, the basics are discussed as applying to the technique in general, irrespective of end use. Since the book is intended as an engineering reference text, the physics and mathematical background material has been held to a minimum.

* * *

"IMPEDANCE MATCHING," "ELECTROSTATICS," "D-C CIRCUIT ANALYSIS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.*, New York. 119, 64, and 72 pages respectively. Prices $2.90, $1.35, and $1.35 respectively. Soft cover.

These are three of the latest titles in this publisher's "Electronic Technology Series." The first volume above deals comprehensively with the problem of impedance matching at audio and radio frequencies. Various types of "generators" and "loads" are discussed along with many types of impedance-matching devices and circuits. A separate chapter on impedance matching in transistor circuits is included.

The second volume covers electric charges and the nature of the electric field. Electric potential and its relation to capacitance is also discussed. Various electrostatic devices and applications are covered.

The third volume deals with basic electrical concepts including factors

that affect resistance. Simple d.c. circuits are analyzed and the reader is then led to more complex d.c. networks.

All three volumes include many numerical examples, along with review questions and indexes.

* * *

"BASIC ELECTRICITY FOR COMMUNICATIONS" by William H. Timbie, revised by Francis J. Ricker. Published by *John Wiley & Sons, Inc.*, New York. 527 pages. Price $6.25. Second Edition.

The fifteen years that have elapsed since the first edition of this text appeared have seen notable advances in the field of communications. Because of the many new devices and techniques being employed, this second and revised edition has been issued.

Although adhering to the basic plan and approach for which Prof. Timbie is so justly famous, this revised edition has been broadened to include more fields of application. The text now includes industrial electronics and instrumentation as well as communications. There is revised material on circuit analysis, Ohm's Law, Kirchhoff's Laws, and Thevenin's Theorem in order to take advantage of the newer approaches to these subjects.

New material includes discussions of metallic rectifiers, crystal diodes, transistors and other semiconductor devices, the application of thyratrons to controlled rectifiers, industrial applications of gaseous tubes, and the time constant in capacitive and inductive circuits.

The inclusion of twelve appendices and a generous helping of test problems at the end of each chapter makes this book suitable for home study if the student has an adequate background in mathematics.

* * *

"ELECTRONIC MEASURING INSTRUMENTS" by E. H. W. Banner. Published by *The Macmillan Company*, New York, 491 pages. Price $7.95. Second Edition.

This is a new and revised edition of a British text which originally appeared in 1954. Written for the instrument engineer, instrument user, advanced student, and nuclear research engineer, the text covers the principles of electronic instruments, their principal types, and component devices. Because many such measuring devices include vacuum tubes and CR tubes, there are two sections devoted to these components.

The instruments covered in the text include devices used in industrial, scientific, and medical applications. Service instruments, with the exception of the vacuum-tube voltmeter, are not included. The equipment discussed, diagrammed, and illustrated is of British manufacture but since most of the units have U. S. counterparts, the validity of the material is not impaired.

This edition carries, in addition to amplified and up-to-date data on the material discussed in the earlier volume, new sections on special reliability and subminiature tubes, junction transistors, thermo-variable resistors (thermistors), waveform error, multi-wave voltmeters, flying-spot microscopes, portable radiation pyrometers, metal rectifier instruments, survey and combination meters, recorders, palladium leak detectors, electronic tachometers, etc.

* * *

"NUCLEAR ENERGY" and **"MECHANICS"** by Alexander Efron. Published by *John F. Rider Publisher, Inc.*, New York. 63 and 112 pages respectively. Prices $1.25 and $1.50 respectively. Soft cover.

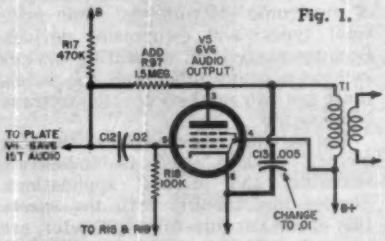
Above are two of the latest volumes in the publisher's "Basic Science Series" which provide the reader with a rigorously accurate but readable and interesting coverage of the various separate areas of physics. These books start at a level suitable to the general reader and then proceed to a junior college level.

The first volume introduces basic atomic theory, nuclear particles, sources and applications of nuclear energy, and includes the modern physicist's view of the atom. The second volume is an interesting treatment of basic mechanics. Such topics as vectors; moments and torques; kinematics, force and motion; work, energy, machines, and power are thoroughly treated. —30—

IMPROVE PACKARD-BELL AUDIO

On receivers using chassis 2710 and 2720—these include models 2721 to 2724—over-all audio quality can be improved by a simple change involving two components. Capacitor C_{12}, a .005-μfd. unit connected between plate and cathode of the audio-output tube (V_5, 6V6), should be replaced with a .01-μfd.

Fig. 1.

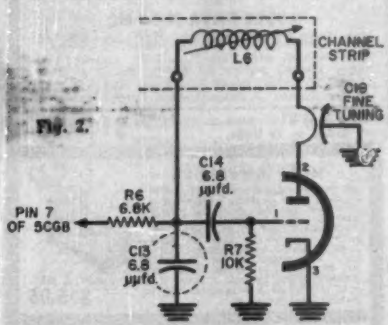


capacitor. At the same time, a 1.5-megohm resistor, designated as R_{37}, should be added between the plate of this stage and the plate of the 1st audio amplifier (V_4, 6AV6). These changes are shown in Fig. 1. The two components involved and their locations are indicated by the heavy lines on the schematic.

FIRESTONE: FREQUENCY DRIFT

Some TV receivers using neutrode tuners, like the 25A1148 front end, may show a tendency to shift frequency while in operation, requiring re-adjustment of fine tuning. Models that may be so affected are in the series from 13-G-210 to 13-G-226. The probable cause is a defective capacitor in the circuit of the local oscillator, C_{28} in Fig. 2. Due to faulty tinning of the ceramic disc, this 6.8-μμfd. unit may

Fig. 2.



have an intermittent internal connection. Replacement of the component is the remedy.

In putting in a substitute part, several precautions must be observed. Since C_{28} is a special temperature-compensated unit, it cannot be replaced indiscriminately. It must have a tolerance of ±5% and an N2200 characteristic. An exact replacement is *Standard Coil* part No. 13R-007. The soldering iron used should not be rated at more than 50 watts. Also a fork-shaped iron tip should be used to facilitate removal of the defective component. This will permit the simultaneous application of heat to both sides of the capacitor.

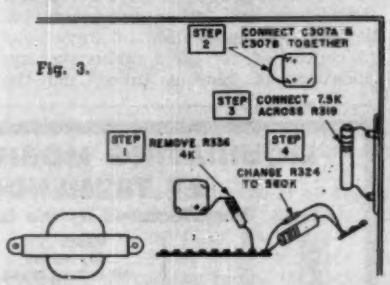
ADMIRAL: PIX CUT-OFF

When a very strong video signal is being received on models using chassis 21B1 or 21F1, the video amplifier may be driven to cut-off, thus blocking the picture signal from the picture tube. Also, when this amplifier is cut off, there is an increase in the "B+" applied to the CRT cathode. As a result, the picture tube is likewise cut off, and the viewing screen will be entirely dark.

Ordinarily, a.g.c. action works to prevent such a condition. However, since the a.g.c. section in these receivers depends on the video amplifier, once the latter is cut off a.g.c. is ineffective. However, the addition of two resistors, the change in value of a third, and a wiring change can correct this condition, as shown in Fig. 3.

Changes are as follows: 1. Remove resistor R_{326} (4000 ohms). 2. Connect the positive terminals of filter capaci-

Fig. 3.



tors C_{307A} and C_{307B} together. 3. Shunt a 7500-ohm, 5-watt resistor across R_{319}. 4. Change resistor R_{324} from 180,000 ohms to 560,000 ohms, ½ watt.

TRAV-LER: AUDIO ARCING

When the cabinet top is removed to service the underside of the chassis in models 1700, 1710, and 1710U, arcing may result at the socket of the audio-output tube, which is the pentode section of VT_5, a 6AW8. Since service involves unloading the secondary of the output transformer, signals reaching the grid of the output tube cause excessive peaks in the plate circuit. This results in arcing between the plate (pin 9) and the screen grid (pin 8) which may permanently damage the tube socket. A warning sign will appear in the form of white flashes in the picture.

To prevent damage, the secondary leads of the output transformer should be joined together, or an external speaker load should be connected. If neither of these measures is convenient, the minimum preventive step should be turning the volume control to its lowest position to keep signal off the grid. —30—

Hot Chassis? Play It Safe

(*Continued from page 63*)

windings has gone open will serve the purpose. Instead, a vertical-output transformer with a step-up ratio of about 10:1 will be suitable. If a new transformer is going to be purchased, the latter choice will be less bulky and less expensive. Do *not* use an auto-transformer, unless you open up the insulation, carefully separate the ends of the connected wires, and install an additional lead.

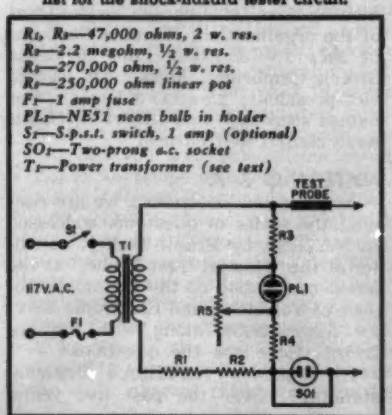
After construction, the unit is readily calibrated by connecting a 180,000-ohm resistor across its output, from the test socket to the test probe. Potentiometer R_6 is then adjusted to the point where PL_1 just begins to glow faintly. The 180,000-ohm resistor is then removed and the unit is ready to use with the bulb brightly aglow.

Testing a receiver for shock-producing shorts takes but a few seconds. Simply plug the receiver into the test socket, turn it on, and apply the probe to various sections of the cabinet, handles, exposed antenna connections, and so on—in short, any exposed portion of the receiver that might become live due to a defect. While this is being done, the set should be jarred lightly to expose intermittent shorts that might be caused by loose metal shavings, intermittent contact between live parts and the cabinet, and the like. In the event of a short or leakage, the neon bulb will cut out or dim. As long as the bulb continues to glow at full brilliance, chassis-to-cabinet resistance is normal.

If a short is indicated, the most likely trouble points will be the .01-μfd. bypass capacitor of Fig. 2A, the antenna isolating capacitors of Fig. 2B, and over-length or improperly inserted chassis mounting bolts. Improper positioning of insulating washers, standoffs, and other material designed to prevent contact between chassis and cabinet is also possible.

If you are lucky, the tester may never diagnose a fault—but why take a chance? —30—

Fig. 3. Schematic diagram and parts list for the shock-hazard tester circuit.



Service Industry News

THE STEADY march of independent service toward unification of effort was emphasized this year in the success of many of the association-promoted conventions that have gained recognition as established, annual events. One of the most significant trends in this process has been the growing interest in correlating association effort at the state level. With very active statewide associations now operating in a dozen states, the pattern of success that has been established by several of these organizations is capturing the interest of all association officers and members.

The first statewide association of record was formed in Pennsylvania about ten years ago. This organization was set up by a group of radio service associations and was initially incorporated as the Federation of Radio Service Associations of Pennsylvania.

At the time FRSAP was formed, the bulk of TV service in eastern metropolitan areas was in the hands of relatively large contractors. These companies were inclined to look with some disdain on the efforts of the smaller shops in TV service work. Ironically, most of the service contractors of that period have long since faded from the TV service scene.

Shortly after the formation of the Pennsylvania Federation, the Empire State Federation of Electronic Dealers Associations was organized in New York State. Almost from the outset, however, ESFEDA ran into difficulties. These resulted from the differences of opinion among the affiliates over national-association affiliation. While some of its locals were members of NATESA, a group of them joined with other eastern associations to form the National Electronic & Television Service Dealers Association (NETSDA). This split appeared to rob the Empire State Federation of needed unity.

In 1951, delegates from associations in the four largest cities in Texas met and formed the Texas Electronic Association. In their efforts to correlate the activities of local associations on a statewide basis, TEA officers decided to center its annual convention around a 3-day clinic and electronic service fair that would be rotated from year to year among the four largest cities. The first of these events was held in Fort Worth in 1953. It proved to be an outstanding success. In the succeeding years, the competition among the "host" cities to outdo the previous shows resulted in the steady growth of interest in TEA's annual clinics.

In recent years, statewide organizations in Connecticut and Indiana have shown progress in developing cohesive programs. IESA, which held its second annual service fair and convention during the early Fall, is embarked on an educational program to acquaint dealers and technicians with the provisions of the statewide licensing law they hope to have passed at the next session of the Hoosier Legislature.

The California State Electronic Association has been moving steadily forward under the guidance of its new executive secretary and former president, H. Lawrence Schmitt. He is a former president of RTASCV and is currently active in TSDA of San Mateo County. The address of CSEA is: H. Lawrence Schmitt, Executive Secretary, 330 Ventura, Apt. 2, Palo Alto, Cal.

In the Buckeye State, TESA-Ohio appears to be bringing into existence a truly representative statewide organization. With local associations in Cincinnati, Columbus, Springfield, Toledo, and Cleveland carrying the ball, the organization has developed a rotating-meeting plan that will bring its work to the attention of all service dealers in the state.

Massachusetts, which justly merits recognition as the home state of the first effective radio technicians' association, recently witnessed the first statewide convention of its Electronic Technicians Guild. Of the nine local associations currently active in the Bay State, two of them still retain a name connection with the original guild. The RTTG of Fall River and the RTTG of New Bedford carry the TV-modernized name of the first Radio Technician's Guild, which was formed in Boston almost thirty years ago.

Officers were elected at the first statewide convention to head the ETG for the coming year. Nicholas Averinos of the *Colonial Radio & Appliance Co.*, 519 Columbian Street, South Weymouth, Mass., was chosen as president of the organization; Edmund Chebator of *Ed's TV & Radio Lab*, 26 Cedar Street, Cambridge, Mass., was elected vice-president; Leonard Smith was named secretary, and Albert N. Giddis were chosen as treasurer.

NATESA Q & A

As promised last month, we are running the series of questions addressed to NATESA by Frank Teskey, co-editor of the "Hoosier Test Probe," at the latest convention of the National Alliance of Television and Electronic Service Associations, along with the answers. Here are the questions:

1. What is NATESA's financial standing? Over the past five years,

how much money has come in, from whom, and how was it spent? Have there been any receipts from any other type of organizations such as labor unions, manufacturers, distributors, NEDA, EIA, etc.? Have there been any expenditures to any such groups? How much money does NATESA presently have? How much does it owe?

2. How is NATESA incorporated? Who are the incorporators, where was it incorporated, and under what conditions? Who owns the NATESA name and emblem? Who owns the "NATESA Scope?"

3. What is NATESA's liability to Frank Moch? What about salary voted in the past, but uncollected, for Frank Moch? Could this come due at some future date and embarrass the association? What about any fees possibly collectable at a later time for past services rendered?

4. What would happen to NATESA if Frank Moch was voted out of office?

5. What liabilities, due to corporate structure, would individuals (as associate members) or local affiliates incur by joining NATESA? Can either local affiliates or associate members be sued if NATESA could not pay some future judgment that might be levied against it? How about the individual members of local affiliates?

6. Would it not be better all around if membership in NATESA were by state associations, where these existed, rather than having the dual status that now exists?

7. Dues. What does NATESA do with the $5.00 per individual member (minimum of $50.00) it collects from each affiliate? Does each and every affiliate pay this amount? Are there, or have there been, any special deals? Is this large amount of dues necessary? If so, how is it planned to use them? Huge surplus funds are unwise.

The answers supplied by NATESA and adhering closely to the oral reply delivered by Frank Moch at the convention, are as follows:

"1. The financial condition of NATESA is very sound. As a non-profit corporation, we operate on a pay-as-you-go basis. This is possible to a great degree because of volunteer services of officers. The actual expenditures for any period are reported by the treasurer to the Executive Council and can be verified by any member checking with the treasurer at conventions. No money has ever been paid to or received from any manufacturer, union, or other group, except, of course, revenue derived from advertising in the 'NATESA Scope' and Yearbook which is sold *without* selling our principles."

"2. NATESA was incorporated in the District of Columbia as a national, non-profit corporation. Since NATESA principal offices are located in Chicago, NATESA is, in keeping with laws of Illinois, also incorporated under what is known as the Alien Corporations Act. The original incorporators were the eight charter members. New officers are reported, as required by law, each year to the Illinois Secretary of State. The NATESA name and emblem are copyrighted at Washington by NATESA. NATESA owns the 'NATESA Scope.' A sizable sum was paid into the treasury by 'Scope' for several years, voluntarily and despite the fact that Frank Moch's personal investment has not yet been repaid."

"3. Frank Moch, entirely voluntarily, at the 1958 convention, waived claims to all past due salaries which had accumulated to the sum of $30,000."

"4. If Frank Moch is voted out under due process, nothing happens, providing, of course, that someone else will undertake the fulfillment of the job."

"5. The liabilities of individual members or affiliates are limited by virtue of operation under the non-profit corporation act. They are virtually nonexistent."

"6. Membership by states is already part of the NATESA rules, but if it is meant that this should preclude direct membership of local affiliates, then the answer is definitely 'no.' First, only eight states have state groups and their importance varies greatly. There is even no unanimity of opinion on the actual value of state groups. Second, electronic service problems are *not* based on state lines and, in fact, adjoining groups in several states often have much more in common than groups in the same state. Third, the problems of groups in the same state often are diametrically opposed. Fourth, to permit a few highly populated states to dominate NATESA by proxy voting is highly undemocratic and unacceptable."

"7. Dues are uniformly collected. How much *is* $5.00 per year? Could anyone be serious in asking, 'Is this large an amount of dues necessary?' What dues do you pay locally and what do you get for them? We believe you will agree quickly that the question is ridiculous if you add up only a few basic costs borne by NATESA voluntarily for regular and special materials and services:

	Per Year
Individual 'Scope' each month, actual cost	$3.60
Certificate	.50
Decalcomania	.15
Pressure-sensitive sticker	.15
Each local member's minimum share of basic material given to each affiliate, such as Organizational Handbook, Affiliate Certificate, etc.	1.50
Total	$5.90

This does not include general stationery, phone, telegrams, printing, postage, bulletins (of which there were about 120 in the year 1957-58), travel, or other normal costs. Instead of questions about 'large dues', the question should be, 'How can NATESA do so much for us at so little cost?' "

ESFETA-State Cooperation

A meeting between Robert Larsen, president of the Empire State Federa-

tion of Electronic Technicians Associations, and New York State Attorney General Louis J. Lefkowitz has been most profitable. Arranged by ESFETA secretary, George Carlson, the conference was highlighted by the Attorney General's proposal that ESFETA create a statewide grievance committee. The five-man committee was formed with ESFETA vice-president, Irving J. Toner, filling the post of chairman.

Mr. Toner's address is 703 Main St., East Aurora, N. Y. All consumers with complaints on service are urged to direct themselves to this address. Affiliates of ESFETA are being asked to publicize this committee and its location. Non-affiliated groups are also urged to contact Mr. Toner for assistance in dealing with local complaints. Formed with the knowledge of the Attorney General, the committee is expected to have his cooperation and support.

ESFETA members have also met with Dr. Persia Campbell of Governor Harriman's Consumer Council to discuss her recent investigation of service in the Albany, Troy, and Schenectady areas. Dr. Campbell appeared anxious to work with the association. Strongest suggestion to come out of the meeting was a proposal for legislation requiring all service dealers in the state to itemize all repair bills. Also suggested was a law requiring the words "rebuilt picture tube" to be written on all bills where applicable.

New Rhode Island Group

The Electronic Dealers of Rhode Island, recently chartered as a non-profit corporation in Rhode Island, selected its officers for 1958-59 at a recent meeting. Those elected to handle the several offices include: president, Norman F. Gladu, 30 James Street, Providence; vice-president, Donald DiBiaso, 748 Cranston Street, Providence; secretary, Len Erickson, 15 Wilson Ave., East Providence; corresponding secretary, Ray Cohen, 97 Broad Street, Providence; treasurer, Ben Lauretti, 801 High Street, Lonsdale, R. I.

Jobber Lauds Association

The "Parts Peddler," a newsletter issued by *Radio Parts of Arizona*, a Phoenix jobber, recently spoke very highly of the action taken by the Better Electronic Service Technicians (BEST) Association of that city, to participate in a joint State-Federal Electronic Apprenticeship Training Program. The "Parts Peddler" reported:

"Under this new plan, the Government pays no part of the apprentice's salary. He must earn the small salary he will get at the beginning of his training. All applicants are screened so that only capable, earnest men can even start apprenticeship training. No shop gets a trainee unless the shop wants one. BEST has taken on a very difficult and arduous task. They are to be very highly congratulated." —30—

6- and 10-Meter Transistorized Amateur Receiver

By E. J. HOLTKE, W5YRJ

AN article describing a transistorized 10-meter receiver, which appeared in the September, 1957 issue of this magazine, stirred the imagination of this author. Could the same results be obtained with a lower-priced transistor? If so, would it work at higher frequencies than 10 meters?

The circuit and layout as described in the original article appeared to provide a good starting point. The major differences, as can be seen in Fig. 1, are partly the result of component availability (the ubiquitous junk-box). The transistor, V_1, was selected for its cut-off frequency characteristic (50 mc.). This *Texas Instrument* unit is a grown-diffused-junction germanium transistor especially designed for 18 mc. r.f. amplifier operation.

It was decided that the first attempt would be for a 10-meter receiver, then if satisfactory results were obtained, to push on for 6 meters. The author learned, after several attempts, that a high-"Q" coil is a "must" for this type of operation. This coil, L_2, was wound with #14 tinned copper wire and mounted in a horizontal position. The one-turn link, L_1, was made from #26 insulated wire interwound at the collector end of the coil. Adjust the coupling between L_1 and L_2 for maximum signal.

A swamping resistor, R_2, was added across the audio choke to suppress an audio howl that developed at 50 mc. This resistor may not be required if CH_1 is of lower inductance than specified in the parts list.

The audio transistor, V_2, was biased by the addition of R_3 which increased the audio output appreciably. The exact value for this resistor will depend on the transistor used and should, therefore, be selected by trial for best results.

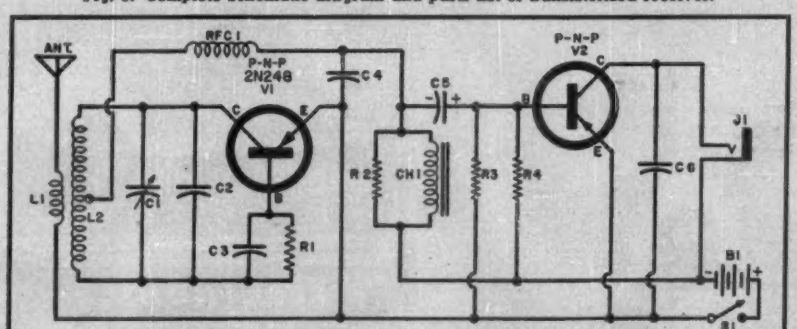
The *LC* combination shown provides a tuning range of 27 mc. to 55 mc. An 8-foot antenna permits reception on 10 and 6 meters while a 5-foot antenna will handle 6 meters adequately. A longer antenna will give better results, but presents a problem in portability. The headphones used with this receiver should be of the 500-1000 ohm type.

The author was pleasantly surprised by the reception obtained on 10 meters —KZ5, W6, to mention a few. The performance on 6 meters was much better than expected, especially in view of the 50 mc. cut-off frequency of the transistor. A test was conducted between K5AON and K5CHF. The fixed transmitter was a *Gonset* linear (60-watt) unit with a vertical antenna on a 48-foot tower. At six miles, reception was solid using a 5-foot whip on the receiver.

As a further check on the sensitivity, a *Hewlett-Packard* signal generator was used, connected to the antenna link. At 20 μv., modulated 30 per-cent with a 1000 cps tone, the signal was readable on both 28 mc. and 50 mc.

Since the local services between 10 and 6 meters were also received clearly during subsequent tests, it is probable a bandspread system would be an aid to tuning. -30-

Fig. 1. Complete schematic diagram and parts list of transistorized receiver.



R_1—430,000 ohm, ½ w. res.*
R_2—15,000 ohm, ½ w. res. (Optional, see text)
R_3—270,000 ohm, ½ w. res.
R_4—100,000 ohm, ½ w. res.
C_1—4-30 μμfd. trimmer*
C_3—5 μμfd., 200 v. capacitor*
C_2—500 μμfd., 200 v. capacitor (exact value will depend on audio transistor used)*
C_4, C_6—.002 μfd., 200 v. capacitor
C_5—4 μfd., 25 v. elec. capacitor
L_1—1-2 t. link (see text)
L_2—12 t. #14 tinned copper, ½" dia., space-wound and center-tapped (see text)*
RFC_1—1 mhy. r.f. choke
CH_1—30 hy., 1 ma. choke (UTC SSO-5)
S_1—S.p.s.t. switch
B_1—9-volt battery
J_1—Open-circuit jack
V_1—"p-n-p" transistor (2N248)
V_2—"p-n-p" transistor (2N291, 2N188, etc.)
** Note: Parts so indicated are critical and should be duplicated exactly for best results.*

1958 INDEX
VOLUMES 59-60

As a service to our readers we are again presenting a complete listing of all feature articles which appeared in RADIO & TV NEWS during 1958. We suggest you keep this for reference.

BOOK REVIEWS

BUSINESS MANAGEMENT

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO & TV NEWS published Monthly at Chicago, Illinois for October 1, 1958

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Ziff-Davis Publishing Company, 434 So. Wabash Ave., Chicago 1, Ill.; Editor, William Stocklin, One Park Avenue, New York 16, N. Y.; Business manager, Howard Stoughton, Jr., One Park Avenue, New York 16, N. Y.

2. The owner is: Ziff-Davis Publishing Company, 434 So. Wabash Ave., Chicago 5, Ill.; Estate of William B. Ziff, One Park Avenue, New York 16, N. Y.; A. M. Ziff, One Park Avenue, New York 16, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

H. STOUGHTON, JR., business manager.

Sworn to and subscribed before me this 18th day of September, 1958.

[SEAL] WILLIAM PROEHMER, Notary Public.
(My Commission expires March 30, 1960)

GENERAL

COMPUTERS

CONSTRUCTION PROJECTS

IGY

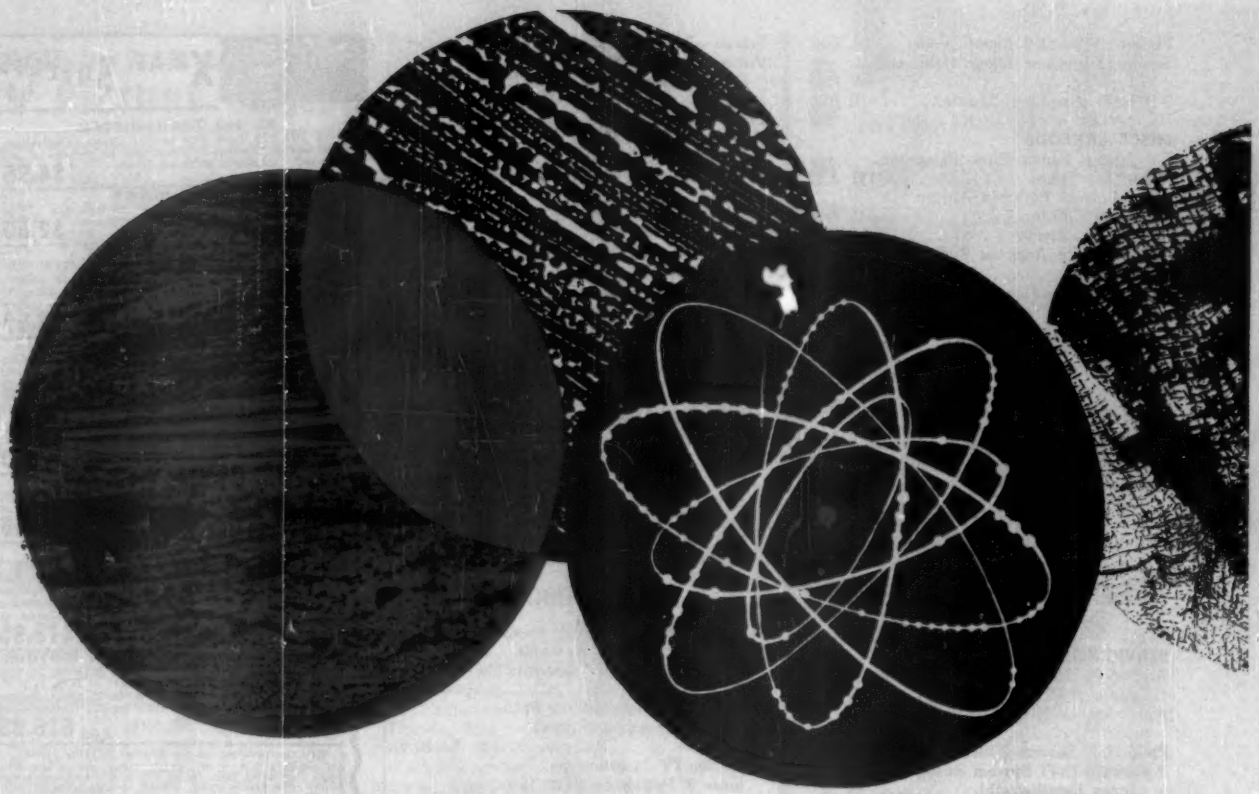
MISSILES & MILITARY

PUZZLES

HIGH-FIDELITY AUDIO

TELEVISION

(Continued on page 158)



ELECTRONICS WORLD...

What's in store for the Electronics World in 1959? What new frontiers will be opened...equipment perfected...techniques improved?

The staff of RADIO & TV NEWS has put together this brief rundown of possible developments and trends in the industry during 1959. In such a dynamic field, we too have to work ahead...estimating far in advance the events and achievements which will deserve editorial coverage in the year ahead.

Here's the way we see it. And in the months ahead, you'll see it, too—more complete and more authoritative than anywhere else—in the pages of RADIO & TV NEWS, the world's most widely read technical electronics magazine.

HI-FI STEREO

Equipment manufacturers expect 1959 to be an even bigger year for hi-fi components and parts. More and more Americans will become interested in the world of high fidelity sound. And 1959 will see the growth and refinement of stereo—possibly lower prices, certainly new equipment and techniques. RADIO & TV NEWS will serve a twofold purpose: by reporting on ways to get the utmost enjoyment from existing equipment and records, and by giving expert advice on the best purchases in new tapes and discs.

SERVICING

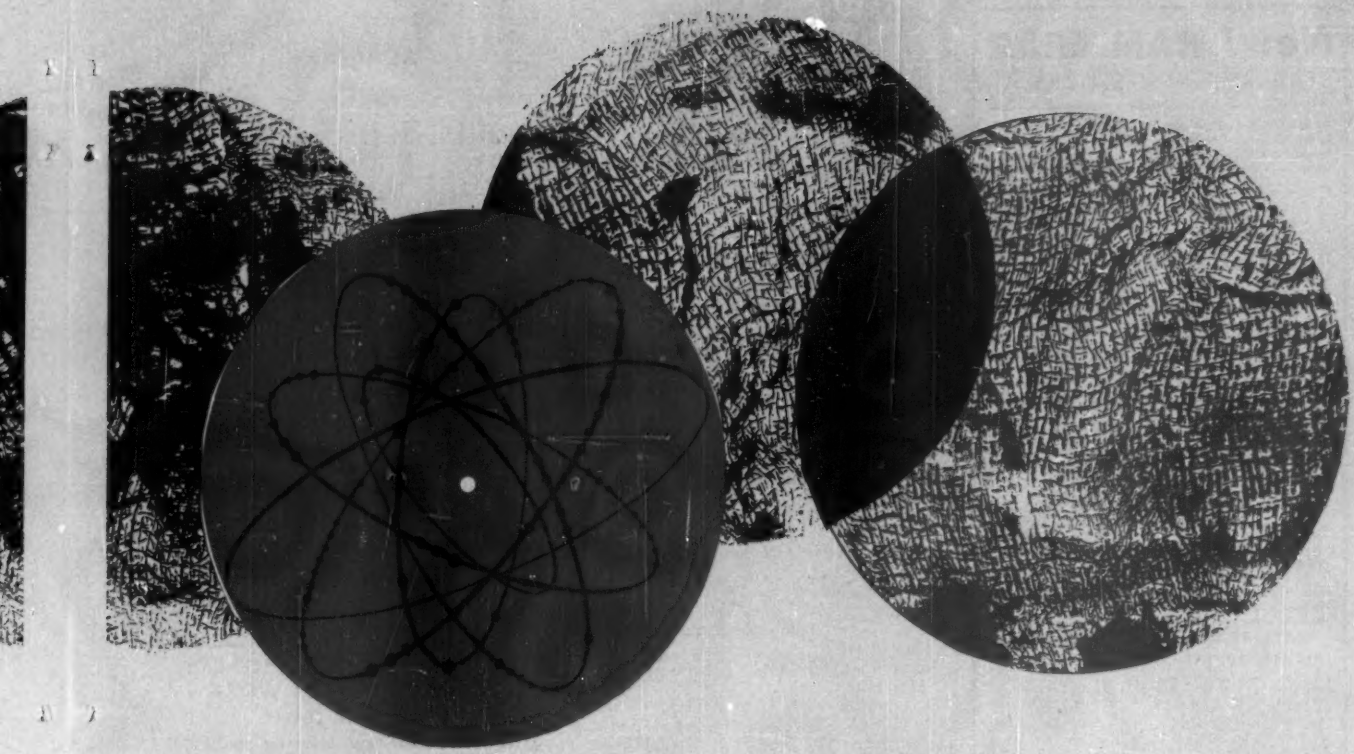
The service technician will find more material than ever before in RADIO & TV NEWS—all designed to help him make more money in his day-to-day operations. Two new facets of servicing look big for '59:

1) COLOR TV—There'll be more sales of color TV sets next year, because of the growing number of top TV programs being presented in color. This means an increased demand for service technicians who have the know-how to install and repair these complex sets. The pages of R&TVN will give you charts, diagrams and expert tips on getting into this lucrative field.

2) INDUSTRIAL SERVICING will become even more important as automation becomes widespread in industrial plants. This is a golden opportunity for the service technician—with more jobs available than ever before (both on a full-time and free-lance basis).

SATELLITE PROGRAM

Whether electronics is your profession or your hobby, you'll want to be well-informed on developments in satellites, rockets, and missiles. RADIO & TV NEWS will keep you up-to-date on the techniques of tracking missiles, transmitting signals, receiving and interpreting information—and what the results mean.



..1959 *A Message from the Publisher about the Coming Year...*

IGY PROGRAM

Much of the information and results of the International Geophysical Year will be released to the public for the first time in 1959. This will lead to a number of major break-throughs in such fields as meteorology, aurora and air glow, cosmic rays, oceanography, seismology, gravity, solar activity, glaciology, geomagnetism, and ionospheric physics.

There is no doubt that these findings will lead to better navigation, improved radio communications, and better weather forecasting. And what is learned from this great scientific experiment is sure to make itself felt in other fields in which electronics plays a major role. RADIO & TV NEWS will report *in depth* on the major findings on the IGY—and how these findings affect the various facets of electronics.

INFRA-RED

Here's a division of electronics that will assume tremendous importance in the years ahead—in solving re-entry problems for satellites, in medical analysis (particularly in the detection of cancer), and as a replacement for radar in defense. The editors of RADIO & TV NEWS believe that the uses of Infra-Red will mark a significant era in electronics and have planned several articles on the subject.

As never before, 1959 will prove that this is indeed an Electronics World! And whatever your field of interest, you'll find it covered thoroughly in the coming year in RADIO & TV NEWS. That's why you would be wise indeed to make sure you get every issue of RADIO & TV NEWS during 1959.

Oliver Read
Publisher

REGULAR SUBSCRIPTION RATES:
one year $4 two years $7 three years $10

ZIFF-DAVIS PUBLISHING COMPANY
One Park Avenue, New York 16, New York

TEST EQUIPMENT

—30—

OLD PM SPEAKER MAGNETS AID PM SPEAKER WORK

By A. VON ZOOK

BEFORE discarding defective small PM speakers, it is a good idea to remove the voice-coil magnets and save them. Small magnets have many uses about the service bench. One worthwhile application comes up when it becomes necessary to drill out the rivets of a defective audio-output transformer that is mounted on the frame of its associated PM speaker. When such drilling is done, iron filings are generally attracted to the magnet in the speaker itself. An otherwise good speaker may be ruined in this way. If some small magnets salvaged from old speakers — about four will do — are grouped about the rivet to be drilled out, iron filings will be attracted to these magnets rather than to the one in the speaker itself. —30—

"Chief wants to see you, Reilly."

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PNP—Stock No. X-752
Similar to General Transistor GT-222, General Electric 2N107 and Raytheon CK-722.

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Two piece, two quart polished aluminum popper with black bakelite handle and feet. Transparent heat resistant cover. Will operate on any standard appliance cord. 115 volts AC or DC. 400 watts. U.L. approved. 8½" h. x 7⅝" dia. Shpg. wt. 3 lbs.

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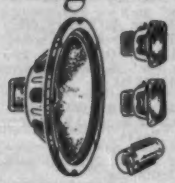
Receives regular broadcast band (550 to 1700 KC) & short wave (6 to 18 MC). Two tubes plus rectifier. With formed chassis, speaker and instructions. Less tubes. Shpg. wt. 7 lbs.

Tubes for above.
Stock No. AS-403 ..... $4.16

Magnavox 4-Piece High Fidelity SPEAKER SYSTEM



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COMPLETE
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If you have been waiting for a first quality, Hi-Fi Speaker System, at a low, low price—wait no longer. This is it! Genuine Magnavox quality construction throughout. The 15" Woofer delivers powerful bass and amazing mid-range response. 8 ohms. Rated at 20 watts with a response of 40—8,000 cps. Heavy cadmium plated frame, dust cover and 1" dia. voice coil. Combine the 15" Woofer with the two 4" Tweeters, that reach a peak of 17,000 cps, add the special non-polarized capacitor and your assurance of full range brilliance is guaranteed. Shpg. wt. 12 lbs.

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To 17,000 cps. 8 ohms
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WANTED: Model A460 Field Strength Meter Mfg. by Approved Electronic Instrument Co. Van Horn Cable Company, Van Horn, Texas.

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WORLD Renowned Hartley Speakers now available to Dealers, Servicemen, Custom Installers, lowest franchise requirements in high fidelity, Write Hartley Products Company, 521 East 162 Street, New York 51, N. Y.

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AMPEX, Concertone, Crown, Ferrograph, Presto, Tandberg, Pentron, Bell, Sherwood, Rek-O-Kut, Dynakit. Others. Trades. Boynton Studio, 10RT Pennsylvania, Yonkers, N. Y.

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INDEX OF Advertisers

DECEMBER 1958

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

KT-500 IN KIT FORM **74.50**

New! Years Ahead!

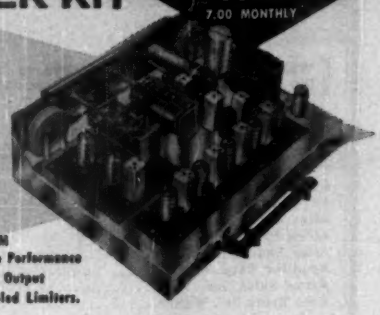
LAFAYETTE STEREO TUNER KIT

ONLY **$7.45** DOWN 7.00 MONTHLY

Use it as a Binaural-Stereophonic FM-AM tuner

Use it as a Dual-Monaural FM-AM tuner

Use it as a straight Monaural FM or AM tuner



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- Multiplex Output for New Stereo FM
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- Armstrong Circuit with FM/AFC and AFC Defeat • Dual Double-Tuned Transformer Coupled Limiters.

More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8-kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500 ..... Net **74.50**

LT-50 Same as above, completely factory wired and tested..... Net **124.50**

NEW! LAFAYETTE PROFESSIONAL STEREO MASTER AUDIO CONTROL CENTER

KT-600 79.50 IN KIT FORM

ONLY **7.95** DOWN — 8.00 MONTHLY

The Lafayette KT-600 Solves *Every* Stereo/Monaural Control Problem!

- RESPONSE 10-25,000 CPS ± 0.5 DB • TAPE HEAD PLAYBACK EQUALIZATION FOR NEW 4-TRACK STEREO • 1.78 MILLIVOLTS SENSITIVITY FOR 1 VOLT OUT • LESS THAN .03% IM DISTORTION • 6 CONCENTRIC FRONT PANEL CONTROLS • 4 CONCENTRIC REAR PANEL INPUT LEVEL CONTROLS • 180° ELECTRONIC PHASE REVERSAL

- UNIQUE STEREO & MONAURAL CONTROL CENTER FACILITIES!
- OUTSTANDING PERFORMANCE SUPERIORITY!
- AMAZING NEW BRIDGE CIRCUITRY & CONTROL FOR 3d CHANNEL OUTPUT FOR 3-SPEAKER STEREO SYSTEMS!
- VARIABLE CROSS-CHANNEL SIGNAL FEED ELIMINATES "PING-PONG" EFFECTS!
- PRECISE "NULL" BALANCING & CALIBRATING SYSTEM — BETTER THAN METERS!
- 24 EQUALIZATION POSITIONS PER CHANNEL!
- CLUTCH-TYPE DUAL VOLUME-BALANCE CONTROLS!

A REVOLUTIONARY DEVELOPMENT IN STEREO HIGH FIDELITY. Provides such unusual features as a Bridge Control, for variable cross-channel feed for elimination of "ping-pong" (exaggerated channel separation) effects and for control of a 3d-channel output for 3-speaker stereo systems; the 3d-channel output also serves for converting stereo program material to high quality monaural for recording or to play a stereo program monaurally through a separate amplifier and speaker system. The KT-600 also has full input mixing of monaural program sources (such as tape recorder and phonograph, etc.), a special "null" stereo balancing and calibrating system (better than meters), 24 equalization positions per channel, 12 db per octave rumble and scratch filters, and a loudness on-off switch. Has clutch-type dual concentric volume controls which operate independently for balancing or simultaneously as the Master Level Control. Other features include channel reverse, 180° phase reversal, input level controls at all inputs. Sensitivity is 1.78 millivolts for 1 volt out. Dual low impedance outputs ("plate followers," 1300 ohms) are provided. Frequency response is 10-25,000 cps ± 0.5 db; less than .03% IM distortion. Uses 7 new 7025 low-noise dual triodes. Size 14" x 4⅛" x 10⅛". Shpg. wt., 16 lbs. Complete with printed circuit board, modern-styling metal chassis and cage, profusely illustrated instructions, all necessary parts.

LAFAYETTE KT-600 Stereo Preamplifier Kit ..... Net **79.50**

NEW! LAFAYETTE STEREO/MONAURAL BASIC POWER AMPLIFIER KIT

KT-310

ONLY 4.75 DOWN 5.00 MONTHLY

47.50

- 36-WATT STEREO AMPLIFIER—18-WATTS EACH CHANNEL
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- EMPLOYS 4 NEW PREMIUM-TYPE 7189 OUTPUT TUBES
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- RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS
- LESS THAN 1% HARMONIC OR INTERMODULATION DISTORTION

A superbly-performing basic stereo amplifier, in easy-to-build kit form to save you lots of money and let you get into stereo now at minimum expense! Dual inputs are provided, each with individual volume control, and the unit may be used with a stereo preamplifier, for 2-18 watt stereo channels or, at the flick of a switch, as a fine 36-watt monaural amplifier — or, if desired, it may be used as 2 separate monaural 18-watt amplifiers! **CONTROLS** include 2 input volume controls, channel Reverse switch (AB-BA), Monaural-Stereo switch. **DUAL OUTPUT IMPEDANCES** are: 4, 8, 16 and 32 ohms (permitting parallel (monaural) operation of 2 speaker systems of up-to 16 ohms. **INPUT SENSITIVITY** is 0.45 volts per channel for full output. **TUBES** are 2-6AN8, 4-7189; GZ-34 rectifier. **SIZE** 9-3/16"d (10-9/16" with controls) x 5¼"h x 13¼"w. Supplied complete with perforated metal cage, all necessary parts and detailed instructions. Shpg. wt., 22 lbs.

KT-310 Stereo Power Amplifier Kit ..... Net **47.50**

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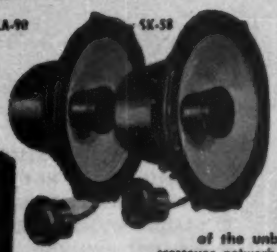
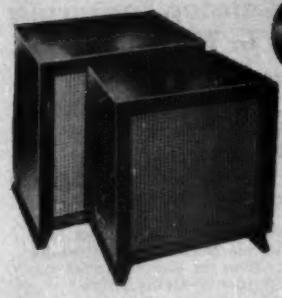
AN IDEAL QUALITY SYSTEM FOR LISTENING TO THE NEW HIGH-REALISM STEREO SOUND!

For Stereo & Monaural Reproduction

NEW GE GC-7 STEREO COMPATIBLE CARTRIDGE WITH DIAMOND STYLUS





COMPONENTS	
Lafayette LA-90 28-Watt Stereo Amplifier	72.50
Garrard RC121/II Changer	41.65
Lafayette PK-111 Wood Base	3.95
GE GC-7 Stereo Magnetic Cartridge	23.47
2-Lafayette SK-58 Coaxial 12" Speakers	59.00
Total Reg. Price	~~200.57~~

YOU PAY ONLY 167.50—SAVE 33.07!

A complete superb stereo hi-fi phono music system brought to you by Lafayette to bring out the thrilling capabilities of the new stereo recordings. Heart of the system is the new Lafayette LA-90 with 28 watts per channel and with all the inputs necessary for a complete stereo control center. Other fine components are the famous new Garrard RC121/11 4-speed automatic record changer ready to accept stereo cartridges, the Lafayette PK-111 wood base for changer, of fine selected woods; the new GE GC-7 stereo/monaural variable reluctance cartridge with 0.7 mil genuine GE diamond stylus; and 2 of the unbeatable, for performance-value, Lafayette SK-58 12" coaxial speakers with built-in crossover network and brilliance level control. Supplied complete with cables, connectors, and easy-to-install instructions. Shpg. wt., 66 lbs.

HF-374 Stereo Phono System, with mahogany or blonde wood changer base (please specify) ..... Net **167.50**

HF-375 Same as HF-374 but with 2-Lafayette CAB-16 mahogany or walnut or CAB-17 blonde Resonator-type speaker enclosures (specify which) ..... Net **222.50**

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Same as HF-374 above but with new Lafayette stereo Model LT-99 FM/AM Tuner.

HF-376 Stereo FM/AM-Phono System ..... Net **237.00**

HF-377 Same as HF-376 but with 2-Lafayette CAB-16 mahogany or walnut or CAB-17 blonde speaker enclosures Net **292.00**

LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.

• Self-Powered • DC On All Filaments • 24 Positions of Equalization
• Tape Head Input, High Impedance • Dual Cathode Follower Output Stages

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾"w 9⅛ x 3¼". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. ..... Net **39.50**

LT-30—Same as above completely wired and tested with cage and instruction manual. Net **59.50**

DELUXE 70 WATT BASIC AMPLIFIER

• Conservatively Rated At 70 Watts • Inverse Feedback • Variable Damping
• Metered Balance And Bias Adjust Controls • Available In Kit and Wired Form

Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wire range linear Chicago output transformer, variable damping control, meter for bias and balance and gold finish chassis. Frequency response 10-100,000 cps ± 1db. Hum and noise 90 db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1 db. Output impedance 4, 8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7⅛" including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. ..... Net **69.50**

LA-70—Same as above completely wired and tested with cage and instruction manual. Net **94.50**

COMPLETE STEREO PHONO SYSTEM KIT

• ASSEMBLE THE STEREO AMPLIFIER AND SAVE REAL MONEY

• PLAYS STEREO AND MONAURAL RECORDS

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Enjoy fine stereo performance with this "easy-to-assemble" exclusive Lafayette package. The complete system consists of Lafayette KT-126 basic stereo phono amplifier kit, the renowned Collaro TSC-640 4-speed automatic record changer, the new Ronette "OV" Turnover Stereo cartridge with dual sapphire styli for stereo and monaural records, and two Lafayette SK-109 Miniature Hi-Fi Speakers and Enclosures. The amplifier kit has many fine features including 2 watts per channel with separate volume control, "stereo-reversal-monaural operation" switch, and isolation transformer to eliminate shock hazard. The 4" x 6" 5 watt speakers are housed in beautiful mahogany wood cabinets, work from either 4 or 8 ohm outputs and are supplied with 25 ft. of cable for hookup. You save 16.58 over regular catalog prices!

PK-299 Stereo Phono Kit System ..... Net **59.95**

KT-126 Stereo Amplifier Kit Only. Complete with all tubes, parts and instructions. Shpg. wt., 7 lbs. Net **18.95**

COMBINATION MONEY SAVER

The KT-126 Stereo Amplifier Kit and Ronette "OV" Stereo Turnover Cartridge with dual sapphire styli.

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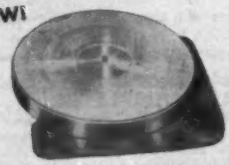

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Professional 4-speed player ideally suited for stereo. Has magnetic eddy-current brake permitting ± 10% speed variation. Amazingly low priced! Shpg. wt., 14 lbs.

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STEREO BALANCE VU METER

Dual audio output level indicator with two meters, for comparing audio levels. Ideal for balancing hi-fi stereo systems.

TM-40 ..... Net **8.95**

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LAFAYETTE-GOODMANS 12" 3-WAY SPEAKER

- 30 WATTS
- FREQUENCY RESPONSE 30-20,000 CPS
- PLUG-IN 12 DB/OCTAVE CROSSOVER NETWORK WITH LEVEL CONTROL

Custom-built by Goodmans of England with 1¾ lb. Alcomax 3 Magnet. Features axially mounted, free-edged wide range woofer, stiff-coned mid-range radiator and compression-driver tweeter.

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NATIONALLY ADVERTISED 4-SPEED AUTOMATIC RECORD CHANGER

NEW GE GC-7 STEREO CARTRIDGE WITH DIAMOND STYLUS

Plays Stereo and Monaural Records

Famous brand latest model with **new GE GC-7 Magnetic Compatible Stereo Cartridge with diamond stylus.** Guaranteed to please or money refunded! Regular 69.50 Value! Shpg. wt., 21 lbs.

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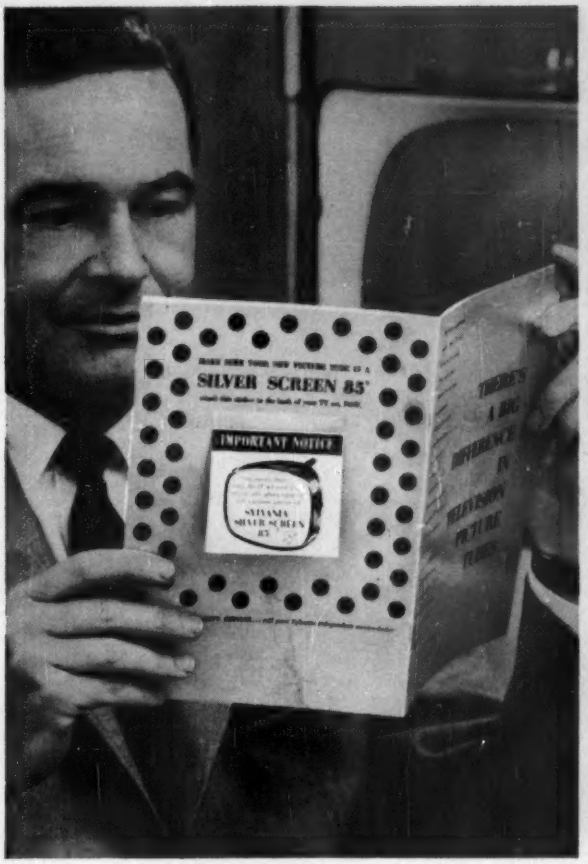

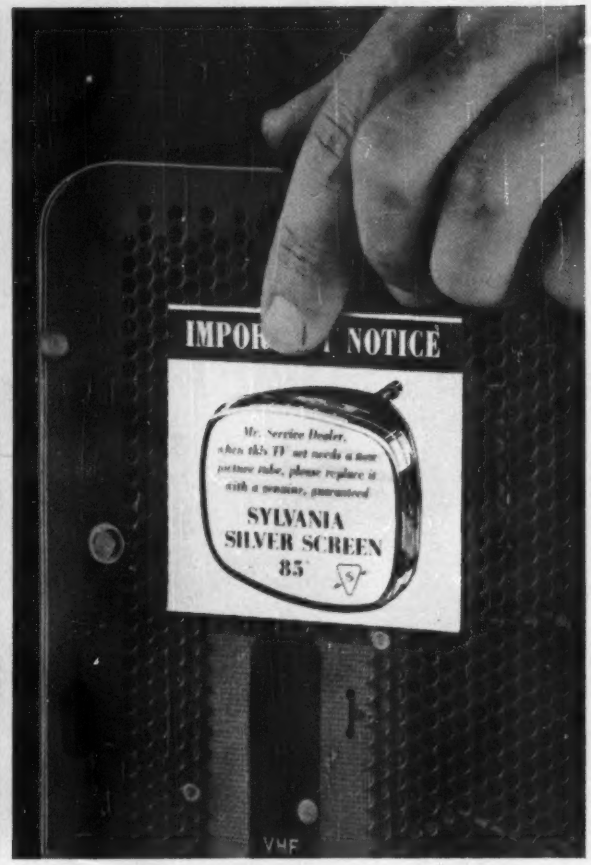

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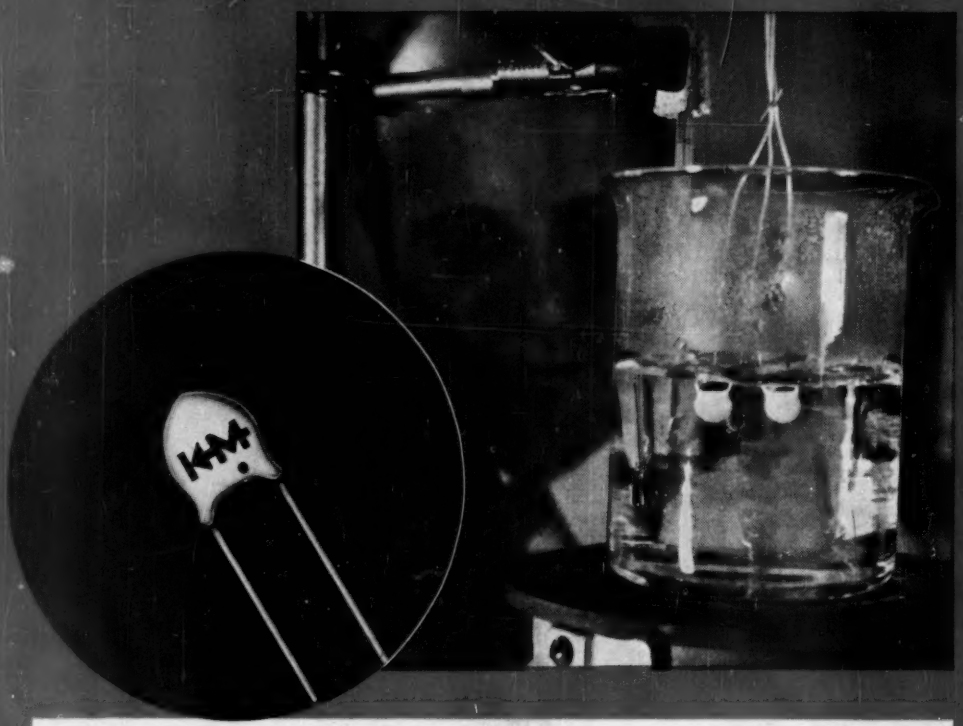

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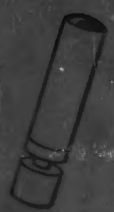

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